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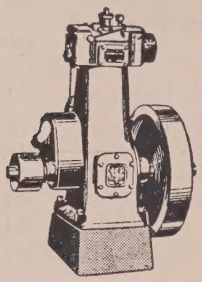

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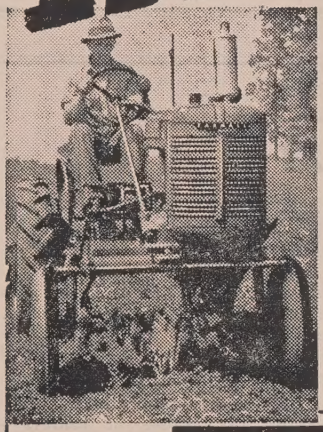

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The New South Wales Division of Agricultural Economics

By

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*Division of Agricultural Economics, N.S.W. Department of Agriculture, Sydney.**

The N.S.W. Department of Agriculture has made history in Australia by establishing a Division of Agricultural Economics. This marks the end of an era in Australian agriculture. It has long been recognised that agriculture differs from secondary industry in that it is unable to carry out its own scientific research. It was in order to carry out this research and to disseminate the results among the farmers that each State Government long ago organised its department of agriculture, with its research and field staffs. But such research (and also all Commonwealth research in agriculture through the C.S.I.R.) has hitherto been confined to the physical and biological problems of agriculture. Until recently the economic and social problems have been regarded as coming wholly within the ambit of the individual farmer. The establishment of a Division of Agricultural Economics implies an official recognition of the fact that the problems of economic organisation, as well as the technical problems affecting the farmers' welfare, are problems which require collective effort in order to overcome them, and that they are as much a specialised study as plant breeding, entomology, veterinary science, or soil chemistry.

It will probably be agreed even in these days of pre-occupation with economic problems that such matters as breeding and disease control logically come first in history even if not first in order of urgency in the present day. Without the work of the scientists, who have diligently tackled one threat after another in these fields, there might be no agriculture and no animal industry in Australia today and, therefore, no economic problems to solve. Moreover, the struggle in these non-economic

* In many parts of this article I have borrowed heavily from an editorial statement on the same subject written by Mr. J. G. Crawford, M.Ec., in the October number (No. 2, Vol. IV) of the "Australian Journal of Science". I have also had the benefit of Mr. Crawford's criticisms in writing the article. The section on the Land-Use and Farm Management Survey being undertaken by the Division, was written by Mr. L. C. Holmes, B.Agr.Sc.

fields is not merely a matter of the past ; it is a continuous fight in which the price of victory is unremitting study. It is important to keep this perspective at a time when many, particularly field officers, find that it is often the economic problems which are predominantly forced upon their attention. The economic problems are the urgent problems of the day, not because the technical problems are any less important than they have ever been but because the latter have been and are being tackled, while economic troubles have been free to breed, multiply and spread without any expert analysis of their nature and, therefore, without any concerted attempt to eliminate or control them, since scientific control must necessarily be based upon prior analysis. It is in this light that I consider the formation of the new Division an important step forward in the development of government aid to rural industry.

However, the functions of a Division of Agricultural Economics are commonly misunderstood to some extent, even by those who have been the most consistent propagandists in favour of the establishment of such a body. We hear, for instance, that " the problem of production has been solved, but the problem of distribution remains ". So runs the cliché. By " distribution " is frequently, if not always, meant marketing. To people who think along these lines the chief work of the agricultural economist lies in the field of predicting market prices, examining cases of maladjustment between supply and demand, exploring new markets, etc. Actually, *the field of marketing is only a relatively small part of the province of the agricultural economist* and, in many respects, one of the least promising. Furthermore, it must be kept in mind that the N.S.W. Department of Agriculture already has a Division of Marketing. It is neither true that the problem of production has been solved nor that production is wholly a technical matter. " Over-production " is a purely relative term, which can be understood only in relation to price. If price is too low to make production profitable, some cry " raise the price ", while others urge " reduce production ". But there is a third course of reducing costs and this is a matter of *economic organisation*, both *within farms* and *within industries*, as well as a technical matter. Consequently economics may make its contribution to the apparent problem of marketing chiefly in the field of production. If by reorganisation in any particular case the cost of production can be brought below the level of the market price, we shall hear no more about over-production in this industry. Such a solution is obviously the desirable one, since it alone brings benefit to the farmer without bringing detriment to the community. This much has been said to indicate that the usual dichotomy, of production as a technical matter and marketing as an economic matter, is quite false. Both production and marketing have their technical aspects, and both have their economic aspects. The economics of production must be placed as the major section of the work of the agricultural economist. The discussion of what these economic problems in the sphere of production are, takes us into a more detailed study of the functions of the new Division.

The Economics of Production

All problems in agricultural economics relate to organisation in a broad sense of the term—to using a given set of resources in one way instead of another way. One general type of study of which this is obviously true is the land use group. While a particular pattern of land-use develops naturally out of a given set of geographical and institutional factors (of which prices, government policy regarding such matters as land alienation, and wage standards are perhaps the chief elements) it does not follow that there exists at any point of time the best distribution of production for prevailing conditions. Natural adjustments often show a very serious time-lag. A pattern of land-use having been built up, both private and social interests become vested in that particular pattern since a great deal of capital becomes fixed in a form suitable only to that pattern. Existing skills and habits are also an obstacle to change. Thus, there is a natural resistance to any change and this resistance may

take the form of subsidising a pattern of land-use which has become uneconomic, thus actually preventing the natural adjustments which would otherwise occur in time. Sometimes the initial land-use pattern is determined by quite unusual conditions—" dead end " forces—which quickly pass away, leaving a problem of maladjustment behind them. An extreme example of the things discussed above is provided by the so-called " marginal lands ", such as the " South-West ". In these instances only a centrally-planned and co-ordinated attack on the problems has made readjustment possible, and all States have found some form of land-use survey an essential preliminary to the practical problem of reconstruction. The " marginal lands " provide an extreme example, but it is probable that some degree of maladjustment in land-use is fairly common, particularly if we allow for questions of erosion and loss of fertility. Some desirable objectives in the determination of land-use can never be brought effectively within the price system through which all natural adjustments must take place.

A closely related study to land-use is farm management, in which land-use is studied in more detail, the broader geographical and institutional factors (such as size of farm) being taken as given. The implications of a farm management survey are considered later when dealing with a study being undertaken by the Division. Here we need only add that closely related to the investigation of farm organisation are the cost-of-production survey and the development of farm book-keeping. When dealing with production costs, the economist is much more interested in the range of costs from low to high cost farms, than in the average cost which is given a quite unjustified significance in political discussions. For instance, how various combinations of factors (size of farm, capitalisation, sidelines, tenure, machinery, etc.) are correlated with various cost levels, is obviously a vital question in determining desirable organisational types. Again, the economist is more concerned with the cost of running the farm as an enterprise than with the cost of producing an individual commodity. These two considerations explain why cost studies fit in particularly well with farm management or organisational studies. The need for book-keeping in efficient farm management and also in supplying the economist with his data is sufficient to guarantee that every student of farm organisation becomes interested in developing and popularising an elementary and suitable system of keeping farm accounts. It is to be hoped, however, that in the course of time farm management and book-keeping will acquire a certain degree of status as an independent study, which is closely related to, but hardly within the field of agricultural economics.

Land-use and farm management studies take all aspects of the economic organisation of production within their purview and study their relation to one another within a given area. But many of these aspects often require independent investigation along quite different lines. One of the most important of these is the influence of technological change, of which mechanisation of farming is an important aspect. Research here would attempt to collect and systematise data on the number of man-hours required to cover a given area of ground by each kind and type of farm implement ; to measure the rate at which various types are being substituted for older types ; to deduce the effect on labour employment per acre ; and to examine the relation between mechanical trends and trends in the size of farms. Arising out of these studies will emerge the question of what are the possibilities for cooperative use of large-scale farm machinery. Technological progress is one of the major dynamic forces at work in agriculture in Australia. Developments occurring today foreshadow changes in the volume of production and in the number of men we can usefully have in agriculture in, say, ten years' time, yet we have no systematic knowledge of just what these changes are or at what speed they are occurring. How then can we plan to prepare for their effects ?

Other matters which have an important bearing upon the efficiency of our agricultural organisation are the size of farms and the debt structure of primary

industry. No attempt is made to outline here the lines along which such studies would develop. The investigation of production costs on an industry, as distinct from a regional, basis is also a quite independent field of study. It is impossible to over-emphasise the importance of the study of the correlation between production costs and such factors as farm size, types of equipment, sidelines, location, rainfall, soil types. These are essential if there is to emerge a picture of the best lines (economically speaking) along which to guide the development of agriculture.

Another field in which agricultural economics may reasonably be expected to make some contribution is the study of the economic aspects of various agricultural practices. Practices that readily come to mind are pasture improvement, fodder conservation, growing of wheats of better baking quality, use of certain crops in a rotational system and soil conservation. It may be good agriculture to farm in a certain way, in that gross returns are increased or soil fertility is built up, but it is not necessarily good economics for the farmer, as it may increase costs by more than it increases returns. This is not to say that an agricultural practice should be judged purely by its short term effect on the individual, but it is to suggest that in cases where a practice is recommended although it is not directly profitable to the individual, it should be clearly recognised that this is the case. What is needed is some determination of the costs to the individual where a practice is recommended for social reasons. Where short-term private and long-term public interests coincide, we need more exact data on the limits (geographical, price, etc.) within which practices recommended for agricultural reasons pay. Such knowledge would benefit the agrostologist or the wheat-breeder, for instance, in that it would place him on surer ground.

Income Studies.

There are also certain matters which do not require field studies in which the Division should be able to make contributions to rural welfare. Among this group of studies is the investigation of the ways and means of reducing year to year fluctuations in farm incomes. This implies a critical analysis of various types of price stabilisation schemes and an examination of the possibilities of crop insurance, such as operates in the United States. Devices for shielding farmers from fluctuation in market prices by placing a stabilisation fund as a buffer between producers and consumers can take a wide variety of forms. Such proposals always have economic repercussions in addition to the specific effects they are framed to produce and it is the business of the agricultural economist, who is accustomed to watching for the interplay of economic forces, to recognise these potentialities and point out their significance. Arising out of this critical approach to existing schemes it is hoped to be able to devise a plan which will overcome most of the disadvantages of the various stabilisation plans which have been propounded to date . . . Crop insurance is unknown in this country, except against specific hazards, such as hail or fire. In the United States a scheme for " all risk " insurance for wheat has been available to wheat farmers for three seasons now, and it is about to be introduced in respect of cotton also. A rather different system of *compulsory* insurance against all climatic hazards has been mooted in the Argentine. Under the United States scheme the farmer pays a premium before sowing his crop and, in return, receives an indemnity if his yield falls below 75 per cent. of his normal yield, equal to the difference between his actual yield and 75 per cent. of his normal yield. The amount of the premium varies from farm to farm, depending upon the risk involved for the Federal Crop Insurance Corporation. Thus the plan has a proper actuarial basis. Neither Crop insurance nor price stabilisation is intended to subsidise the farmer. They are self-supporting schemes whereby the Government is able to offer the farmer shelter from the devastating fluctuations in gross income which play such havoc with the rural economy. The principal problem in crop insurance is to devise a sound

actuarial basis and this can be done, even if statistics are available, only under certain conditions. It will be a task of the Division to consider whether Australian conditions are such that crop insurance, for wheat for instance, is feasible and, if so, whether there exists at present reliable data on which to build such a scheme.

Another matter on which existing statistical data could throw a great deal of light, if it were examined with this purpose in mind, is the actual level of farm incomes in relation to incomes in other sectors of our economy ; and the distribution of incomes of different grades as between industries and between regions and between farms of various sizes, tenures, etc. Obviously, such data as this must be compiled if we are to go in for a system of farm aid in any but a hit-and-miss fashion. Is rural industry really a depressed sector of our economy in Australia ? What industries, regions or groups are depressed relatively to others ? Ultimately, we must aim to draw up indices of rural net incomes showing the year to year fluctuations and construct separate indices for various farm types and areas.

On the marketing side, owing to the existence of the Division of Marketing, the Division of Agricultural Economics will not be generally concerned with market prospects, price changes, etc., but the more technical economic aspects of marketing will require its attention. For instance, the economic significance of price spreads between grower and consumer will require attention. Again, we need to know more about the effect on the home market of a given change in the volume of supply of different products or, to use a technical term, " the elasticity of demand ". Government marketing policy is also in bad need of more data on the degree of competition between various agricultural commodities. To what extent are given commodities substitutes and to what extent are they complements. The relevant laws of demand are quite different, depending upon which of these forces is dominant in any given case. Related fields of study, for which these are really preliminary technical researches, are the relation between income and food purchases—in total and in respect to different commodities—and the disposal of surplus commodities. This last implies a critical appraisal of the United States food stamp plan and various other methods used in the United States particularly, with a view to considering what type of a plan is applicable to Australian conditions.

Immediate Objectives.

This review of the field of research open to the new Division is not to be taken as a statement of immediate objectives. It is at once a rough outline of some part of the field of agricultural economics and a statement of long-range aspirations. The first field project of the Division is a land-use and farm management study of a region in the north-eastern corner of the State. This project, which will be exploratory in respect of objectives and technique for Australian conditions, will, it is hoped, be the forerunner of survey work in other areas and industries.

The prime objective is to make a detailed stock-taking of rural activity in this area, and thereby to reveal local farming problems and necessary remedial measures. Farming is both a means of livelihood and a way of life, and ultimately the *real* success or failure of a farming enterprise is the result of the interplay of a miscellany of more or less independent factors, some technical (e.g., pasture improvement), many economic (e.g., size of farm and farm business capitalisation, markets and production costs), and some sociological (e.g., living amenities in the home, facilities for education for the children).

For various reasons, chiefly limitations in the number of staff available, this initial project will be concerned mainly with the economic aspects, and an effort made to reveal the *organisations* and practices responsible for the lower-than-average costs of the most successful 15 to 20 per cent. of the farms in the area. The work will be divided into three sections : first, the pattern of present land-use will be classified, mapped, and related to its predetermining physical and economic factors—

chiefly soil, topography and climate, and disposition in relation to markets and transport facilities. Individual physical factors, such as soil, will not be considered *exhaustively* except in so far as they are limiting or are in themselves largely responsible for problems of land-use.

The second section will embrace a general economic survey of the area. This will consist of fully collating and analysing published and unpublished statistics of individual farms, and obtaining—chiefly in the field from resident officers of the Agricultural and other Departments—technical and other information pertaining to the entire area. While taking into account the limitations of available statistics, and appreciating that many aspects of farm organisation and management cannot be reduced to a statistical basis, such an analysis, if critical and cautious, should provide a more intimate picture of rural activity, give factual data in an assimilable form, and reveal any natural relationship existing between such factors as system of tenure, size of farm, farm capitalisation, numbers and types of livestock, production, and farm population and labour supply. It may also be possible to detect farms which are *typical* or modal in respect of at least some of these factors, singly and collectively.

Thirdly, a *detailed* survey will be made *in the field* of a small sample of farms (of the order of 5 per cent.) which are designedly representative of the whole community of farms. The selection of the sample will be made from the statistics above and will be based on areal (e.g. land type) rather than functional (e.g. source of income, use made of labour) lines. Detailed questionnaires have been prepared and in the period January to March, 1942, the field staff available should cover at least 130 farms.

Probably one of the chief difficulties will be the inadequacy and inaccuracy of farm records. This difficulty could be obviated, in the future, by supplying farmers with a simple single-entry system of farm book-keeping and records. Such a system is being prepared, and copies will be offered to sample-farmers. This might well serve as a starting point for sound continuous farm management and costing research in this and other districts.

Another important project which may well involve some field work at a later stage will be a mapping of the geography of this State. All recorded (but not necessarily published) information is being drawn together in an attempt to make more explicit, for particular areas, the relationships between natural factors and present land-use. It will then be possible to determine what additional survey and mapping in the field would be required to give for the entire State a general but more accurate and complete picture than is available at present of the pattern of land-use and the roles which climate, topography and soil have played in bringing about this pattern.

Work has been started on the problem of the disposal of surplus foodstuffs. The Division is interested in various types of direct distribution and in the possibility of applying to Australian conditions a plan of the type of the American food-stamp plan. This plan is distinguished by two important features: It uses existing marketing channels and it attempts to overcome the age-old problem that distribution of surplus foods, free or below cost, tends to spoil the existing commercial market. Families on relief are eligible (participation is wholly voluntary) to receive free blue stamps which may be presented at shops for any food which is in surplus supply, according to the Surplus Marketing Administration, provided that they *buy* orange stamps equal in value to their usual expenditure on food. These orange stamps can be presented in payment for any type of food. Ideally this ensures that blue stamps are not substituted for money usually spent on food.

It must be stressed that it does not follow that any plan will work in Australia simply because it has been a success in the United States. Even if it is applicable, it will almost certainly need to be considerably modified to meet differences in types

of surplus foods, differences in the relative size of the home and export market, differences in administrative background, differences in available statistical data, differences in consumer-structure, differences in the relative location of food-producing and food-consuming centres and a host of other factors which could be enumerated if any purpose were served thereby. Some lines along which research is planned are : what are the surplus foods in Australia, having regard to annual and seasonal fluctuations and to regional differences ? What is the character of the demand in each case ? What income classes normally purchase each or how are purchases distributed over income classes ? What is the elasticity of demand at various price ranges ? One need consider only the apple and pear scheme to realise how essential it is that attention should be paid to such points as these.

In connection with a food stamp type of plan we must ask under what conditions and to what extent are free stamps likely to be substituted for previous expenditure on surplus food instead of added to it with the result that non-surplus foods receive benefit from the subsidy ? (This involves a much more detailed study of American experience than literature available at present permits). And how accurately can we in Australia determine normal food expenditure for any given family ? Or to what extent must we depend upon averages or even estimates of averages ? Obviously, the problem of ensuring that none of the subsidy is switched to non-food uses is more than an administrative one of blue and orange stamps. We must achieve a reasonable degree of accuracy in determining the so-called " orange-stamp requirement " and make it sufficiently flexible to apply closely to individual cases. As has already been pointed out, if compulsory food expenditure falls below usual food expenditure the subsidy will tend to be wasted to that extent, so far as the benefit to agriculture is concerned, while any increase in compulsory expenditure on food over usual expenditure would often inflict severe hardship on people whose pennies have to be carefully counted.

Some thought is being given to collecting data on technological change and to the economics of growing hard wheats. To date, no projects have been started on these topics, but these will be commenced as soon as the pressure of existing work permits. The severe limitations on the volume of research that can be carried at present may be seen from the fact that the full-time research staff numbers only four persons to date. Of these four, two are at present engaged on the land-use and farm management survey and the related broad geographical survey of New South Wales, while one has a large part of his time taken up by purely administrative duties. This staff is working under the general direction of Mr. J. G. Crawford, M.Ec., Economist to the Rural Bank of N.S.W., who has also been serving the Department of Agriculture as an advisory economist for several months. In his latter capacity Mr. Crawford has been asked to direct the research work and accept responsibility for the reports and advice of the Division. The present staff comprises two officers trained in general economics, an agriculturalist who has specialised in economic and social aspects of agriculture and a geographer who has specialised in economic geography. Each of the latter is also taking a university course in economics. Mr. W. H. Pawley, B.A., who specialised in agricultural economics under Mr. Crawford at the Rural Bank is in immediate charge of the administration of the Division as Acting First Assistant. The Second Assistant is Mr. L. C. Holmes, B.Agr.Sc., who is also in charge of the land-use and farm management survey work which the Division is undertaking. Mr. Holmes has had previous experience of field work in agricultural economics in both Victoria and New South Wales. The other members of the staff are Mr. R. B. McMillan, B.Com., and Mr. N. R. Wills, B.Sc. It is planned gradually to expand this research staff to perhaps three times this number. At present, a prime obstacle to expansion is the shortage of qualified workers. The survey of work waiting to be done stresses the need for a more

important place for agricultural economics in the university curriculum in N.S.W. and, in fact, in curricula throughout Australia.

Informational and Advisory Functions.

In the preceding pages attention has been concentrated on the research functions of the Division. However, it has to be remembered that the Division has been constituted to act as an information and advisory service as well as a research body, and this work will naturally occupy a good deal of its time. Into this category will fall the preparation of material for presentation to the meetings of the Australian Agricultural Council and much of the work on war-time problems and post-war reconstruction. It is to be hoped that so far as the last is concerned, an opportunity will be given to carry out genuine research, but it is not for me to say along what lines, if any, research into problems of reconstruction will be undertaken. It must be insisted, however, that, in the long run, it is precisely the research work of the Division which will allow it to carry out most efficiently its work as an advisory body, and purely informational activities should not be allowed to crowd so thickly that they obstruct real investigation.

In its informational work, the Division will, of course, rely principally upon existing statistics, and this brings up the important question of the adequacy of existing statistics for research in agricultural economics. Although many of the projects which the Division must undertake would, in the nature of things, always require field work, it may well be that a great deal of special field work in the future might be saved if thought is given now to what additional data it would be useful and practicable to collect through the ordinary annual returns. This is a major research project in itself, in which it is obvious that the collaboration of the Bureau of Statistics and Economics would be essential. Fortunately, the N.S.W. Statistician has kindly offered the Division the full collaboration of his Bureau, in so far as staff can be spared. One of the tasks which it is expected will be carried out, as a result of cooperation between the Bureau and the Division, is an appraisal of existing statistics, published and unpublished, bearing upon agriculture. Another way in which official statistics on agriculture might be developed is by the institution of some equivalent to the quinquennial agricultural census in the United States. " In this way, simple questions relating to the number of farms, agricultural employment, farm population, mortgage debt, and like matters could be answered more accurately in the aggregate and in detail than is possible now ".* In all these cases, while the final decision must rest with the statistician, the Division must be prepared to undertake in large measure the task of deciding on what statistics are required.

Some Problems of Method.

In a journal for scientific workers in agriculture, some remarks on the peculiar features of research in economics may be in place. A preliminary point which is worth emphasising is that agricultural economics is primarily economics, not agriculture. While agreeing with many of the criticisms made in an article by Mr. Aird in the last issue of this Journal, and agreeing entirely with the statement that " the economics of agriculture needs special study ", and while conceding that the agricultural economist should have some knowledge of agriculture, I am unable to concede that persons trained primarily as technical men in agriculture instead of persons trained primarily in general economic theory are best fitted to become " the authorities on this subject ". As the name states, it is agricultural economics—not economic agriculture, and the concepts, the analytical techniques and tools of thought used are derived from economic not agricultural science. In order to realise this, one has to think only of such concepts as elasticity of demand or supply, marginal costs,

* " Australian Journal of Science ", Vol. IV, No. 2, October, 1941.

prime and supplementary costs, diminishing marginal returns, rigidity of the price mechanism, indifference curves; or to consider the general theory of price, of competition and monopoly, of the exchange of commodities and international trade or of population theory. Each of these analytical weapons and systems of thought, which are essential to the agricultural economist, has been forged in the smithy of general economics.

One important feature which research in agricultural economics has in common with research in agriculture is that projects often require many years for their fulfilment. This is obvious in cases in which the aim is to observe and measure long-term trends as in the impact of technological change on labour requirements. It is less obvious when seeking information on such matters as prices and yields. The economist is unable to isolate the variables he wishes to study from other intruding factors, and in order to minimise distortion from chance fluctuations he has to base his experience as broadly as possible in time and place. "Long-range projects cannot be rejected simply because results may not be immediate. The farm programme of the United States is today benefiting from projects commenced prior to the last war, and the success of the new Division will, in the long run, depend uopn its ability to commence similar work now."*

Perhaps the most fundamental problem which confronts research workers in economics is that this is the field par excellence in which preconceived opinions and prejudices are widely current. Because economic forces impinge directly on the vital interests of everyone, most men at least have given some thought to them. Furthermore, most people have not only worked out their own beliefs, but, from the very nature of the circumstances that forced them into thinking on economic phenomena, they hold theories which suit their particular economic interests. Finally, because these beliefs are based on self-interest and not upon genuine interest in the subject itself, they are not usually discarded simply because they can be logically disproved. Disagreement is inclined to be resented in much the same way as a direct attack upon one's economic welfare, and theories are tenaciously and even fiercely defended as personal possessions. Thus, the economist has to work in a field which differs from the physical and biological sciences in two important respects: In the first place, people who have never made a systematic study of the subject believe they understand it; and in the second place, most people have a vested interest in their economic beliefs. These remarks apply to the farmer as much as anyone else and "at times the truth revealed by the Division's researches may be unpalatable to the farmer and the administrator alike".* But the Division will best serve the interests of all concerned if it is allowed to formulate its conclusions without regard for such factors.

Agricultural economists also differ from most other workers in agriculture in that their material precludes experimentation in most cases. They cannot create an artificial economic problem in a laboratory and so they cannot isolate any particular set of factors. This, as is well known, precludes the quantitative exactitude of the physical sciences, but it should be recognised that social construction does not require the accuracy of engineering to achieve a given task.

Relations with Other Workers in Agriculture.

Agricultural economists do not claim to be able to reconstruct agriculture or even to say what *should* be done about any particular problem. In the first place, it is seldom, if ever, that any problem in agriculture, at the level of action, is a purely economic one. In the second place, the task of agricultural economists, like that of all other scientists, is, as a rule, limited to offering advice. We, too, are technical advisers, not policy makers. Confronted with a certain policy, we endeavour to

* *Loc. cit.*

point out the *economic* effects of such a policy. Asked to achieve a given end, we state that the *economic* measures necessary are so and so. However, we may also be asked *to devise machinery for implementing a given policy* (e.g., suggesting a wheat stabilisation plan that will pay 3s. 10d. f.o.b. on 140 million bushels of wheat). To go a stage further, we may even be asked to work out policy, machinery and economic comment, since in some cases what is practicable depends to a very great extent on what the economic implications of the policy are. But in such cases, it is clear that while the economic comment is our expert opinion, the policy is a suggestion only, that may, or may not, meet with approval and which the Government can rightly reject or accept as it sees fit. If it accepts the policy, it is the government and not the agricultural economist who is responsible for it.

Because economic problems in agriculture are often closely entangled with technical agricultural problems, the Division expects that it will have to cooperate a great deal with other Divisions if it is to make the most of its work. For instance, in formulating a wheat stabilisation scheme or in studying the economics of growing hard wheats it would require the aid of the specialised technical knowledge regarding wheat available from the Division of Plant Industry. No satisfactory scheme for dealing with apples and pears could be formulated without due regard to both the technical aspects and the economics of the industry. Here is a clear case for co-operation between the Division of Horticulture and the Division of Agricultural Economics. And so we might proceed to give illustration after illustration so far as the technical divisions are concerned. This may mean that cooperative projects may play an important part in the work of the Division of Agricultural Economics. The close connection between many of the topics which come within the province of the Division of Marketing and many of those which come under the Division of Agricultural Economics needs no emphasis.

With the Division of Information and Extension Services we hope to establish a close two-way exchange of information. On the one side it is hoped that the Division of Agricultural Economics will be able to give the Division of Information and Extension Services considerable help in the economic aspects of their extension work. On the other side, we shall look to them for the farmers' viewpoint on the economic problems of agriculture. We want to know what problems are engaging their attention and how they envisage the solution to these problems . . . While we expect to work in conjunction with research officers and specialists in other divisions to a considerable extent, it appears to us that our principal connections will be with the field officers of these divisions, who, like those of the Division of Information and Extension Services, provide a link with the farmers. We know that agricultural instructors, for instance, are faced with questions on economics as well as on agriculture, and we hope through their Division to help them to aid the farmer on these problems. We also anticipate that the field officers will be of the utmost value to the Division in procuring field data necessary for the projects we have to undertake, in giving advice on local conditions, in passing on farmers' problems and viewpoints, and in formulating problems typical of their district.

In conclusion, I should like to add that the Division realises that in the long run it will be the cooperation of the farmers and farmers' organisations which will be the essential factor in basic field research. If we cannot always guarantee that individual conclusions will meet with the approval of farmers or certain group-interests in agriculture, we feel that we can say beyond any shadow of doubt that any systematic attempt to reveal the economic structure and dynamics of agriculture must react to the benefit of farmers, since it, and it only, can reveal the economic problems of agriculture in a concerted way and make possible a concerted policy to tackle them.

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Plant Quarantine

Report of the Central Committee appointed by the Australian Institute of Agricultural Science to deal with Overseas Plant Quarantine.

An examination of the Australian system of Overseas Plant Quarantine was adopted as an Institute project by resolution of the second general meeting, Canberra, January, 1939, following the submission of a memorandum on the subject by the Australian Capital Territory Branch. The examination was commenced by Branch Committees whose reports were submitted to a Central Committee which compiled a general report. This was considered at the third general meeting, Melbourne, 1940, which directed that, after further comment by the Branch Committees and any necessary amendment, the report should be forwarded to the Standing Committee of the Agricultural Council.

Before this further review was completed, a conference on Plant Quarantine was convened by the Commonwealth Department of Health. As many of the delegates to this conference were members of the Institute who had also been members of the Plant Quarantine Committees, the Institute report was tabled at the conference and formed the basis of discussion and the report of the conference to the Agricultural Council. In view of this, it has been decided that no good purpose would be served by submitting the Institute Report to the same body independently. It is now printed below, embodying also the few amendments since agreed upon by the Central Committee.

I. INTRODUCTION.

(1) Foreign Plant Quarantine is concerned with legal restrictions that may be enforced with respect to the movement of commodities for the purpose of preventing or delaying the introduction into Australia of foreign plant pests, weeds, and diseases.

(2) Australia, because of its isolated geographical situation, is in a particularly favourable position to benefit from plant quarantine.

(3) It is evident that while the present quarantine system has assisted in preventing the establishment in Australia of certain major plant diseases and pests, such as Citrus Canker, Fireblight of Apples and Pears, European Corn Borer, and Hessian Fly, it has failed to exclude others such as Bean Blight, Bacterial Canker of Tomatoes, Cabbage Butterfly, and Oriental Peach Moth. It is appreciated, however, that no plant quarantine service can be expected to keep out all plant pests, weeds and diseases.

(4) It is agreed that Plant Quarantines must be based on sound biological principles, and objectives must be reasonably probable of attainment from a biological standpoint. They must be economically justifiable and not unnecessarily restrictive. Further, they should never be used for any purpose other than the exclusion of pests and diseases. Hence the organisation of plant quarantine administration should be independent of interests other than that of quarantine.

(5) The requirements of an efficient Plant Quarantine Service are :

(*a*) A well-trained staff.
(*b*) Suitable regulations.
(*c*) Satisfactory equipment and facilities.

II. RECOMMENDATIONS.

As foreign plant quarantine may affect foreign relations and foreign trade, it should be the responsibility of the Commonwealth Government, and further it should be uniformly administered throughout the Commonwealth.

(a) Staff.

(1) It is recognised that while a larger and more highly qualified quarantine staff is ultimately desirable, the present is not the time to consider such a proposal.

However, it is essential to have three specialist assistants with the Director of Plant Quarantine as a central staff, and this is recommended.

(2) The Director should be a university graduate in science or agriculture, with a knowledge of entomology or botany, who has been engaged in applied entomological or plant pathological investigations for several years, and who is also possessed of administrative ability. The assistants should have specialised entomological, botanical, and plant pathological knowledge respectively.

(3) It is essential for the proper prosecution of the work that these officers be enabled to travel freely and, if necessary, overseas.

(4) In order to render possible the formulation of sound quarantines the central staff should study plant diseases and pests, collate the information available regarding their economic importance, life-histories, host-range, world distribution, and the likelihood of their introduction into Australia. They should also undertake a survey of all plants and plant parts imported into Australia over a period of years, in order to determine the identity of pests or potential pests that are associated with particular products in their country of origin, and likely to be introduced along with these products.

(5) It is considered desirable that the Central Quarantine Office act as an information bureau, and serve as a centre to which all information concerning the introduction, subsequent spread, or disappearance, of all introduced pests, diseases, and weeds be sent. The information would then be passed on to the appropriate authorities in all the States concerned, and would be followed by periodical progress reports.

(6) It is recommended that a full-time, well trained Commonwealth Quarantine Officer be employed in each State.

(7) A continuation of the employment of part-time State officers in Commonwealth inspection duties is favoured.

(8) It is recommended that in the future recruitment of inspectors the fulfilment of certain selected courses of study at universities or technical colleges be a prerequisite for appointment. Also that specialised training be given inspectors by the central quarantine staff.

(9) The appointment of an Advisory Plant Quarantine Board such as exists in Canada and South Africa is not recommended, but it is believed that an advisory committee in each State would perform a useful function. The members of these committees would lack official responsibilities, but would be available to assist the Director of Plant Quarantine in matters affecting their own States. It is also considered desirable that a National Advisory Committee, comprising a single representative from each State committee, should be formed to assist the Director of Plant Quarantine on occasion.

(b) Regulations.

(1) Inspection services provide less protection than restrictive regulatory action ; hence the major responsibilities of an effective quarantine service will always rest with the administrative authority.

(2) It is recommended that a review be made of present regulations in order to determine whether in the light of existing knowledge, some should be modified or new ones promulgated.

(3) Although a certain purpose is served by issuing lists of prohibited plant diseases, insect pests and weeds, it is important that separate regulations, having specific intentions, should be promulgated for pests and diseases that are considered a particular menace. These regulations should be clearly worded and accompanied by explanations.

(4) Importations of plants and plant parts should be permitted only under a controlled introduction system. On this basis, material would be introduced only

in such quantities as would permit of proper inspection and adequate treatment under supervision.

(5) It is suggested that nurserymen be licensed under the Quarantine Act before being permitted to import, and that licences be contingent on proper facilities for inspection, treatment, etc., being provided.

(6) Import permits issued in Australia and endorsed in the country of despatch should accompany plants and plant parts imported for propagation.

(7) Provision should exist for demanding, if necessary, that plants be grown in quarantine for a specified period.

(8) All fruit trees, shrubs, and ornamental perennials, as well as being initially inspected, should be grown in quarantine for twelve months.

(9) All trees, shrubs and other perennials, and all plant parts used in vegetative propagation should be given appropriate treatment on arrival. In addition, consideration should be given to the feasibility of treating all imported seeds.

(10) The preparation of a schedule of the most effective treatments for all plants and plant parts is recommended. Such a schedule should be revised from time to time.

(11) It is suggested that defined tolerance limits be set for diseased materials present in introduced consignments of plants and plant parts.

(12) Provision for exclusion or treatment should apply not only to plants and plant products carrying certain pests and diseases, but also to any other article or matter which might be considered likely to introduce such pests and diseases.

(13) It is considered desirable that the travelling and general public should be educated about the danger of indiscriminate plant introduction. Further, special attention should be drawn to the possibility of introducing diseases and pests in plants by post and in overseas passengers' luggage.

(14) If a recently imported serious disease, pest or weed, is discovered, the position should at once be examined to see if eradication is possible, and if considered possible an immediate attempt at eradication should be made. For this purpose considerable funds and a large temporary staff may be needed. It is recommended that a reserve fund be set aside for such a contingency, to be used at the discretion of the Director of Plant Quarantine. Broad plans for action in such emergencies should also be formulated.

(15) Attention is drawn to the danger of plant pests, diseases and weeds being transported in aeroplanes from overseas. It is recommended that the whole matter of preventing such introductions be investigated, and appropriate action taken.

(16) The present position in regard to inter- and intra-state quarantine is unsatisfactory. It is recommended that the existing regulations and procedure be examined with a view to establishing uniformity and efficiency.

(c) Equipment and Facilities.

It is considered that suitable buildings and equipment are essential for the efficient conduct of plant quarantine (the committee feels that any detailed specifications of necessary equipment and facilities must be left to the Central Quarantine Staff). In view of the costly nature of the necessary equipment, it clearly cannot be provided at all ports of entry. Consequently, plants and plant products in certain categories can be permitted entry only at those ports where special facilities are available. Further, it is recommended that a plant quarantine inspector be stationed at every port of entry of overseas goods.

III. PRESENT POSITION.

The organisation and control of all quarantine in Australia was originally a function of each individual State.

It was not until 1909 that the Commonwealth, in view of the international implications, assumed the responsibility for the control of foreign quarantine. In the administration that was subsequently established, human, animal and plant quarantine were grouped together under one Permanent Head in the Department of Health.

Human health was naturally considered more important than that of either animals or plants. The Commonwealth made effective provision for the administration of foreign human quarantine by establishing a Federal organisation, but did not follow the same procedure for the control of either plant or animal quarantine. Unfortunately plant and animal quarantine received comparatively little attention.

The Commonwealth utilised the existing State organisations for the administration of both its animal and plant quarantine regulations, and indeed is still mainly dependent upon the cooperation of the States.

Each State, through the Department of Agriculture, administers its own Act relating to plant diseases and pests. In these Acts there are provisions for inter- and intra-State quarantines. Foreign plant quarantine is administered under the Quarantine Act of the Commonwealth by the Commonwealth Department of Health.

In each State the scope of the respective quarantine Acts varies considerably, and in consequence the extent to which quarantine can be made effective also varies. Furthermore, there is absence of uniformity in procedure under the various State Acts.

The Commonwealth Act (Plant Division) is concerned mainly with the exclusion of diseases and pests from the Commonwealth, and it also makes provision for the promulgation of regulations to check the spread of diseases or pests already established within the Commonwealth.

A Director of Plant Quarantine was appointed by the Commonwealth Government in 1927, and made responsible to the Permanent Head of the Department of Health. No other full-time officer has since been appointed to the Commonwealth service for plant quarantine work. All other officers in the organisation that administers the Commonwealth regulations are appointed at the request, and on the recommendations of, the State Departments of Agriculture, and from the services of these Departments. They are actually State officers seconded for Commonwealth service. The Commonwealth pays the State for the services rendered.

There are approximately 75 quarantine officers engaged in inspection duties for the Commonwealth. Of these, seven spend their whole time on foreign plant quarantine work. The majority of the inspectors have no special training in plant quarantine matters, and the appointment of health inspectors and customs officers to carry out plant quarantine duties suggests that these duties are considered of minor importance. Further, the present apparatus and facilities for the inspection and treatment of imported plants and produce at the majority of overseas ports, are inadequate.

By comparison with the sum spent on the investigation and control of introduced diseases, insect pests and weeds, the amount spent in attempting to prevent the entry of others is a mere pittance.

Additional sums necessary to make the present plant quarantine service efficient should be regarded as an insurance, and the increased expenditure entailed would represent a real economy in the national interest.

A. J. Nicholson
(Chairman).
B. T. Dickson.
H. J. Hynes.
J. W. Evans.

Canberra, A.C.T.
1.10.40.

The Relation of Mineral Nutrition to Seedling Blight Infection in Maize

By

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During the course of investigations at the University of Wisconsin, U.S.A., on the relation of various environmental factors to the development of seedling blight in maize due to *Gibberella fujikuroi* (Saw.) Wr. and *Gibberella fujikuroi* (Saw.) Wr. var. *subglutinans* Edwards, experiments were conducted to determine the effect of nitrogen, phosphorus and potassium nutrition on pathogenesis and seedling growth. This work was carried out in the early part of 1939 during the writer's tenure of a Service Fellowship from the Commonwealth Fund of New York.

The effect of each element was studied in temperature controlled greenhouses maintained at constant air temperatures of 20° and 28° C. Previous investigational work[3] had shown that the lower temperature was favourable for seedling blight development, and although infection normally did not occur at 28° C. it was thought that nutritive factors might modify the normal temperature-infection relationship. At each temperature the nutrition-infection studies involved seedlings of Funk's Yellow Dent maize from grain inoculated externally during germination and Golden Glow maize seedlings derived from internally-infected seed.

External grain inoculation was effected by soaking the seed for 20-30 minutes in an aqueous conidial suspension of either *G. fujikuroi* or *G. fujikuroi* var. *subglutinans*, and then germinating the grain in incubators maintained at the same temperature as that of the greenhouse in which sowing was to be done. During germination the seeds were sprayed daily with a fresh conidial suspension. The control grain received similar treatment but was soaked and sprayed with sterile water instead of the conidial suspension. Transplanting was done when the coleoptiles were about one-half to three-quarters of an inch in length, and only viable grain was transferred to the greenhouse. The internally-infected grain was derived from Golden Glow ears which showed not less than 95 per cent. internal grain infection with either *G. fujikuroi* or *G. fujikuroi* var. *subglutinans*. These ears had been inoculated in the field during the previous summer with a known isolate of either organism, and, as reported previously[2] ear inoculation prior to the dent stage of development caused a high degree of internal grain infection. Grain from ears of the same variety which showed not more than 5 per cent. total internal fungous infection was used for control sowings.

All the nutrition experiments were conducted in 6-inch earthenware pots of washed and sterilised quartz sand. The inner surfaces of the pots were thoroughly coated with varnish prior to the commencement of the work, and all pots were carefully washed and sterilised between each experiment.

With slight modifications, the nutrient solutions used in the present work were essentially the same as those used by Spencer and McNew[5] in their study of the relation of mineral nutrition to the infection of sweet corn seedlings with *Phytomonas stewarti* Bergey *et al.* The salt proportions in the solutions used by these workers were based on solution $T_3 R_2 C_2$ of the Jones-Shive[4] series. The composition of the solutions used in the present investigations is given in Table 1.

The effect of each element was determined in separate experiments and when the concentration of an individual element was varied, the concentrations of the

TABLE 1.

Composition of nutrient solutions used in the different experiments with nitrogen, phosphorus and potassium in relation to seedling blight development in maize.

Stock Solutions 0·5 molar.	Volume of stock solutions per litre of nutrient solution in experiments with		
	Nitrogen.	Phosphorus.	Potassium.
	ml.	ml.	ml.
KH_2PO_4	6·3		
$MgSO_4$	7·1	7·1	7·1
$Ca(NO_3)_2$		3·6	3·6
$CaCl_2$	2·9		
$(NH_4)_2SO_4$		3·6	
$NH_4H_2PO_4$			7·1
NH_4NO_3	0–107·1		
NaH_2PO_4		0–96·8	0·9
K_2SO_4		2·6	0–38·4

other elements were held constant. Five concentrations of each element were tested, the supply levels being 0, 10, 25, 75 and 150 milligrammes of element per 100 millilitres of nutrient solution. Each pot of ten seedlings received 100 millilitres of solution three times per week from the time of emergence till the conclusion of the experiment. In addition, waterings with distilled water were given whenever necessary. Quadruplicate pots of each nutrient treatment for each of the grain classes were maintained at air temperatures of both 20° and 28° C. The actual sand temperatures in the vicinity of the grains were usually 1-2° C. below the air temperatures.

In recording the data, an infection index was used to express the incidence and severity of infection. All seedlings were removed carefully from the pots of sand, washed thoroughly in water and then examined carefully and classified into six infection classes to each of which an arbitrary value was assigned as follows :

1. No evidence of lesions 0
2. Restricted lesions 2
3. Cortical rot involving more than one-third of the subcrown internode 4
4. Seedlings obviously stunted or wilted 6
5. Seedlings killed after emergence 8
6. Seedlings killed before emergence or grain which failed to germinate 10

Maize seedlings showing injury characteristic of each infection class are shown in Fig. 1.

In calculating the infection index, the number of seedlings in each class was multiplied by the class value and the sum of these products was then divided by the number of kernels sown. The quotient is the infection index. After examination of the seedlings for the infection index determination, they were severed at the second or crown node and the top portions were then dried to constant weight in a forced

air drier at 60-70° C. The total dry weight of each lot of material was then divided by the number of component seedlings to give the mean dry weight of the emerged seedlings.

Nitrogen Experiments.

Nitrogen was supplied as ammonium nitrate which furnished equal amounts of ammoniacal and nitrate nitrogen. The amount of nitrogen varied from 0 to 150 milligrammes per 100 ml. of nutrient solution. In each series the amount of phosphorus was held constant at 12·5 milligrammes, and the amount of potassium at 10·0 milligrammes per 100 ml. of solution. The nitrogen experiments involved 2,400 seedlings and the infection indices and the dry weight determinations for both lots of material at each temperature have been summarised in Table 2.

Examination of the data shows that the amount of nitrogen supplied to the plants had no effect on the development of seedling blight. Satisfactory infection occurred in the Golden Glow material at 20° C. with well-defined differences between the control seedlings and those derived from infected grain. The amount of infection, however, was more or less constant for each nutrient level. Seedling blight due to *G. fujikuroi* or *G. fujikuroi* var. *subglutinans* did not occur at 28° C. and both the control seedlings and those derived from infected grain showed approximately the same degree of injury. As reported earlier,[3] this type of injury was independent of inoculation and was associated with constant high temperatures.

The most satisfactory vegetative growth at both temperatures occurred in the series receiving 25 milligrammes of nitrogen three times per week. The seedlings receiving no nitrogen were slightly chlorotic and stunted. In the series receiving 75 milligrammes of nitrogen per application, the foliage of a number of plants was flaccid with a tendency to droop and wilt, while in the series receiving 150 milligrammes of nitrogen all the seedlings showed foliage injury ranging from marginal necrosis of the upper leaves and death of the lower leaves to wilting and complete collapse of the aboveground parts.

Figure 1.

Maize seedlings showing injury characteristic of the six infection classes used in determining the infection indices.

Left to right :

1. Free from infection.
2. Restricted lesions.
3. Cortical rot.
4. Wilted or stunted.
5. Killed after emergence.
6. Killed before emergence.

TABLE 2.

The influence of nitrogen supply on the growth of maize seedlings and on the development of seedling blight caused by Gibberella fujikuroi *or* Gibberella fujikuroi *var.* subglutinans.

Grain Class	Air Temperature and Duration of Experiment	Treatment	Milligrammes of N per 100 ml. of nutrient solution									
			0		10		25		75		150	
			Infection Index	Mean Dry Weight. Milligrammes	Infection Index	Mean Dry Weight. Milligrammes	Infection Index	Mean Dry Weight. Milligrammes	Infection Index	Mean Dry Weight. Milligrammes	Infection Index	Mean Dry Weight. Milligrammes
Golden Glow. Internal Infection.	20° C. 30 days	Control	0·8	125	0·2	127	0·7	152	0·8	128	0·3	117
		G. fujikuroi ..	2·2	101	2·5	101	3·2	122	3·2	105	3·5	103
		G. fujikuroi var. *subglutinans* ..	3·9	70	4·2	91	2·7	113	4·0	80	5·3	72
	28° C. 20 days	Control	1·9	120	1·9	203	2·8	238	2·5	194	3·3	156
		G. fujikuroi ..	2·3	123	2·6	181	3·0	241	3·3	190	3·8	148
		G. fujikuroi var. *subglutinans* ..	1·3	127	1·7	155	2·8	215	2·7	172	3·8	129
Funk's Yellow Dent. External Inoculation.	20° C. 32 days	Control	2·1	79	1·4	132	2·0	141	2·8	143	6·4	66
		G. fujikuroi ..	3·0	84	2·4	127	2·4	149	3·2	151	5·8	99
		G. fujikuroi var. *subglutinans* ..	2·0	91	2·9	119	2·3	170	3·2	146	6·2	102
	28° C. 22 days	Control	3·2	119	2·3	183	3·8	195	5·1	118	4·9	126
		G. fujikuroi ..	2·4	125	2·2	214	2·4	219	3·8	195	4·0	158
		G. fujikuroi var. *subglutinans* ..	2·5	142	2·5	200	3·1	182	4·0	225	4·2	149

TABLE 3.

The influence of phosphorus supply on the growth of maize seedlings and on the development of seedling blight caused by Gibberella fujikuroi *or* Gibberella fujikuroi *var.* subglutinans.

Grain Class	Air Temperature and Duration of Experiment	Treatment	Milligrammes of P per 100 ml. of nutrient solution									
			0		10		25		75		150	
			Infection Index	Mean Dry Weight. Milligrammes	Infection Index	Mean Dry Weight. Milligrammes	Infection Index	Mean Dry Weight. Milligrammes	Infection Index	Mean Dry Weight. Milligrammes	Infection Index	Mean Dry Weight. Milligrammes
Golden Glow. Internal Infection.	20° C. 30 days	Control	0·6	100	0·7	103	0·7	120	0·8	117	0·7	133
		G. fujikuroi ..	1·2	95	1·3	100	1·3	119	2·5	100	2·6	113
		G. fujikuroi var. *subglutinans* ..	3·2	74	4·0	77	3·2	72	2·9	92	4·9	108
	28° C. 18 days	Control	3·5	148	3·7	125	3·1	155	3·1	127	4·0	134
		G. fujikuroi ..	1·9	202	1·7	169	2·0	191	1·7	201	2·2	177
		G. fujikuroi var. *subglutinans* ..	1·2	165	1·3	198	1·2	168	2·0	156	2·0	136
Funk's Yellow Dent. External Inoculation.	20° C. 28 days	Control	0·3	171	0·3	183	0·8	235	0·9	231	2·0	132
		G. fujikuroi ..	1·3	143	1·4	201	1·6	207	2·1	191	2·2	154
		G. fujikuroi var. *subglutinans* ..	1·4	166	2·1	161	1·2	219	2·0	212	2·7	139
	28° C. 17 days	Control	0·5	131	0·6	159	0·6	144	1·0	121	0·8	152
		G. fujikuroi ..	0·3	178	0·7	175	1·0	175	1·2	141	0·7	158
		G. fujikuroi var. *subglutinans* ..	0·5	177	0·5	169	1·4	164	0·2	154	0·8	154

External grain inoculation of Funk's Yellow Dent maize failed to give a satisfactory differential between control and inoculated material at either temperature. At 20° C. true seedling blight infection occurred in both the inoculated series, but the controls were injured with *Penicillium* sp. and *Trichoderma viride* and yielded infection indices of the same order as the inoculated material. At the higher temperature the control seedlings commonly showed greater injury and had a lower mean dry weight than did the inoculated seedlings. This phenomenon, which was due principally to the action of *Trichoderma viride*, has been discussed in a previous paper.[1]

Phosphorus Experiments.

Phosphorus was supplied as monobasic sodium phosphate in amounts ranging from 0 to 150 milligrammes per 100 ml. of nutrient solution. In each series the amounts of nitrogen and potassium were held constant at 10 milligrammes per 100 ml. of solution. The phosphorus experiments involved 2,400 seedlings and the infection indices and the dry weight determinations for both lots of material at each temperature have been summarised in Table 3.

Examination of the data indicates that the different levels of phosphorus supply had no effect on the incidence or severity of seedling blight infection, nor were they responsible for any marked growth differences in any of the series. There was practically no evidence of injury due to excess phosphorus even in the seedlings receiving 150 milligrammes per application.

At 20° C. a considerable amount of seedling blight resulted from both internal seed infection and external seed inoculation, and in each case, marked differences were apparent in the infection indices of the controls and the inoculated or naturally infected material. At the higher temperature very little seedling injury occurred in the Yellow Dent variety and the infection indices for both the inoculated and control series were remarkably low. However, in the Golden Glow material at 28° C. at each nutrient level the control seedlings were injured much more severely and produced much less dry matter than the seedlings derived from the Gibberella-infected grain. As reported previously.[1] investigation showed that this injury was due to *Trichoderma viride* which developed only on the Gibberella-free grains, and since the temperature (28° C.) was unfavourable for the development of Gibberella-seedling blight, the control seedlings were injured much more severely than those derived from Gibberella-infected grain.

Potassium Experiments.

Potassium was supplied as potassium sulphate in amounts ranging from 0 to 150 milligrammes per 100 ml. of nutrient solution. In each series the amounts of nitrogen and phosphorus were held constant at 10 and 12·5 milligrammes respectively per 100 ml. of solution. The potassium experiments involved 2,400 seedlings and the infection indices and dry weight determinations for both lots of material at each temperature have been summarised in Table 4.

Examination of the data indicates that the different levels of potassium supply had no effect on the incidence or severity of seedling blight infection, nor did they influence seedling growth to any appreciable extent, although there was a general tendency for increased production of dry matter at the higher levels of potassium supply.

At 20° C., external seed inoculation of Funk's Yellow Dent resulted in satisfactory infection in each nutrient series with well defined differences in the infection indices of the control and inoculated seedlings. At 28° C., however, comparatively little seedling injury occurred in this material, although, as in previous experiments, the controls were contaminated with *Trichoderma viride*, with consequent reduction in dry weight and some increase in seedling injury.

TABLE 4.

The influence of potassium supply on the growth of maize seedlings and on the development of seedling blight caused by Gibberella fujikuroi *or* Gibberella fujikuroi *var.* subglutinans.

Grain Class	Air Temperature and Duration of Experiment	Treatment	Milligrammes of K per 100 ml. of nutrient solution									
			0		10		25		75		150	
			Infection Index	Mean Dry Weight. Milligrammes	Infection Index	Mean Dry Weight. Milligrammes	Infection Index	Mean Dry Weight. Milligrammes	Infection Index	Mean Dry Weight. Milligrammes	Infection Index	Mean Dry Weight. Milligrammes
Golden Glow. Internal Infection	20° C. 25 days	Control	2·9	163	3·2	154	3·1	164	2·4	204	2·7	162
		G. fujikuroi ..	2·4	107	2·2	144	2·4	114	2·8	132	2·2	145
		G. fujikuroi var. *subglutinans* ..	3·3	110	3·5	90	2·1	139	3·0	121	2·4	146
	28° C. 20 days	Control	3·3	152	3·1	179	2·5	219	2·5	192	2·4	212
		G. fujikuroi ..	3·3	172	3·1	172	2·5	200	2·6	201	2·8	200
		G. fujikuroi var. *subglutinans* ..	2·6	177	2·8	164	3·5	212	2·7	232	3·9	220
Funk's Yellow Dent. External Inoculation	20° C. 22 days	Control	0·1	149	0·1	159	0·2	155	0·4	164	0·2	158
		G. fujikuroi ..	2·3	132	2·5	131	2·3	117	2·7	141	2·9	155
		G. fujikuroi var. *subglutinans* ..	2·0	118	2·5	120	2·2	116	1·4	152	2·4	130
	28° C. 18 days	Control	1·2	207	1·0	182	1·3	215	0·5	264	0·6	212
		G. fujikuroi ..	0·7	238	0·5	230	0·7	234	0·2	263	0·3	233
		G. fujikuroi var. *subglutinans* ..	0·6	208	0·3	260	0·6	244	0·6	274	0·4	277

In the Golden Glow material, well-defined infection differences did not occur in any series at 20° C. Investigation showed that the injury to the control seedlings was due mainly to *Penicillium* sp., whilst the injury to the seedlings derived from the internally infected grain was due to infection with *G. fujikuroi* or *G. fujikuroi* var. *subglutinans*. Despite the presence of Penicillium injury, the control seedlings in each nutrient series had a mean dry weight greater than that of the corresponding seedlings from the Gibberella-infected grain. As in previous experiments, Gibberella infection did not occur at 28° C. and each lot of seedlings showed approximately the same degree of injury. Most of this injury was due to non-parasitic causes associated with constant high temperature, but isolations from the controls showed that in some cases *Trichoderma viride* was also present.

Discussion of Nutrition Experiments.

Observations were made on 7,200 seedlings of two varieties of maize grown at two different temperatures and at five levels of nitrogen, phosphorus and potassium supply, but the reaction of the seedlings to infection with either *G. fujikuroi* or *G. fujikuroi* var. *subglutinans* was not modified by any of the nutrient treatments.

The omission of any one of these three elements from the nutrient solution did not interfere seriously with seedling growth during the first 2-3 weeks. The omission of nitrogen, however, had a slightly greater effect than did the omission of either phosphorus or potassium.

Experiments also showed that when maize was sown in washed sterilised quartz sand and watered regularly with distilled water satisfactory seedling growth was maintained for 10-12 days at temperatures of 24° and 28° C.

It appears, therefore, that the maize grain contains sufficient reserves of essential mineral nutrients to maintain seedling growth for several weeks after germination, and, consequently, during the early stages of growth the seedling is largely, if not entirely, independent of external sources of mineral nutrients. Since the early stage of seedling growth and development is the critical period for infection with either *G. fujikuroi* or *G. fujikuroi* var. *subglutinans*, it is unlikely that soil fertility plays any part in the development of the seedling blight diseases of maize.

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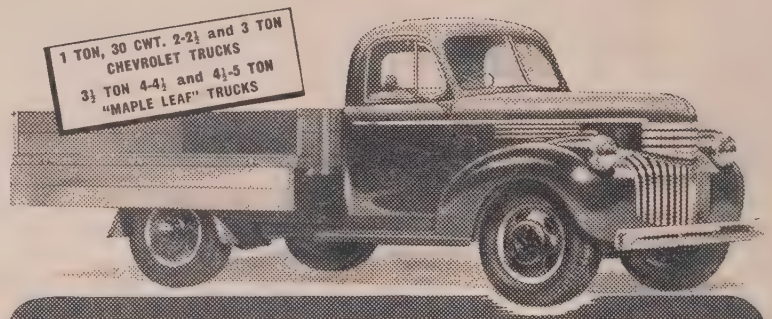

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TECHNICAL NOTES

OBSERVATIONS ON VARIOUS SPECIES OF FRUIT FLIES.

During the past season the Queensland fruit fly, *Strumeta tryoni* Frogg., was unusually active in many parts of New South Wales. Bananas, normally quite free from infestation, were attacked early in the season. Although many stings were observed in green angular bananas, the infestation was mainly evident on bunches containing cracked or damaged fruits. The eggs hatched normally, but the young larvæ, in most cases, failed to penetrate the thick skin. No rush of tannin was observed about the punctures such as described by Back and Pemberton (Back, E. A., and Pemberton, C. E.: The Mediterranean Fruit Fly, U.S.D.A. Bull. 640, 1918) in Hawaii, who stated that the eggs and young larvæ of the Mediterranean fruit fly were unable to survive the tannin in the skin of the green fruit. Development proceeded normally in many fruits and from one sample of 28 bananas 296 specimens of *S. tryoni* were bred out.

Passion fruit were also stung to a considerable extent in the coastal areas and developed the characteristic circular woody growths about the sites of the egg punctures. In most instances no further development took place, but occasionally where larvæ continued to develop they were unable to leave the fruits and the resultant adults were similarly imprisoned.

Tomatoes and blackberries were fairly generally infested, and in addition to these records the following host fruits were also observed to be attacked: *Niemeyera prunifera, Eugenia jambos, E. luehmanni* and giant honeysuckle (*Lonicera hildebrandiana*). The adults were noticeably attracted to the snail creeper, *Phaseolus caracalla*, although no breeding was possible, as the flowers dropped.

Strumeta humeralis, a species new to New South Wales but previously recorded as a citrus pest in northern Queensland, was bred from mulberries, plums and *Niemeyera prunifera* in the Coff's Harbour district and from *Bryonia laciniosa* at Grafton (J. A. Wright in Departmental report).

The Halfordia fruit fly, *Strumeta halfordiæ*, which commonly infests native fruits, was bred from Wheeny grapefruit in the Glenorie district on one occasion. This appears to be the first record of this fly breeding in a cultivated fruit in New South Wales. *S. halfordiæ* was bred in numbers from native plum, *Sideroxylon australe* and also *Niemeyera prunifera*.

Strumeta strigatus was taken on a number of occasions from traps at St. Ives, but no further information is at present available concerning its host fruits.

The small black fruit fly, *Melanodacus niger*, was also taken on two occasions in traps set in a citrus orchard at St. Ives. This species has been bred from the fruit of a native tree, *Symplocos thwaitsei*, in Queensland.

The Mediterranean fruit fly, *Ceratitis capitata*, was bred from citrus fruits in the Kenthurst district and was reported from traps in the Richmond district. A single specimen was recently taken in a trap in a citrus orchard at St. Ives, but this species continues to be rare even in many districts where it was previously abundant many years ago.

The Island or Spotted fruit fly, *Rioxa pornia*, was bred on one occasion from passion fruit from Murwillumbah. This fly is normally considered to be a pest of damaged or over-ripe fruit and its development from such a woody fruit seems surprising. The Island fruit fly was also bred in numbers from *Sideroxylon australe* and *Niemeyera prunifera*.

Laboratory Breeding Cage Records.

The possibility of pest species of fruit flies breeding in native fruits is of considerable importance and a number of breeding tests were therefore carried out. Flies

were fed on a mixture of sugar and peptone, and various fruits were then introduced into the cages.

The Queensland fruit fly, *S. tryoni*, the main pest species in New South Wales, was bred without difficulty in the fruit of the black apple or native plum, *Sideroxylon australe*, even though cultivated fruits were also present in the cages at the time of egg deposition. On the other hand, the common non-pest species, *S. halfordiæ* bred freely in apples and peaches, although fruits of its native host plant were also available. This behaviour in breeding under laboratory conditions is not borne out by general field experience, although *S. halfordiæ* was bred from grape fruit on the one occasion referred to above.

Under cage conditions, unusual egg deposition has frequently been noted and eggs have been laid freely on the glass tops or paper lining of cages when host fruits were not present. Eggs have also been laid on potatoes, carrots, turnips and broad beans, and hatched normally. Further development took place only in the case of the beans, although the full cycle to the development of adults did not occur in this instance.

In addition to the unexpected reversal of field behaviour in breeding under cage conditions, some aberrations in bristle development have also been observed. The examination of a large series of flies from the field or the laboratory will often reveal individuals with missing, duplicated or even triplicated hairs or bristles. This variation may be confined to one side of the body and will then be readily recognised; but specimens may also occur in which the unusual features are symmetrically arranged on both sides of the body. Another type of variation likely to cause considerable taxonomic confusion is the development of bristles in situations normally devoid of them.

The Queensland fruit fly, *S. tryoni*, in normal specimens, has two pairs of inwardly directed inferior orbital bristles on the frons and a single apical pair of bristles on the scutellum. An examination of 356 laboratory bred individuals showed that 62 flies were abnormal in bristle development and, of these, four had three pairs of symmetrically arranged inferior orbitals and another four had two pairs of scutellar bristles also symmetrically arranged. An examination of 215 flies bred from loquats, naturally infested in the field, revealed only one abnormal fly which had an asymmetric variation in one position. Further breeding with these abnormal flies was not possible and it is not known if the variations noted would persist. On the basis of the present schemes for classification, some of the laboratory bred flies might be considered to belong to a species different from that of their parents, while those having the two pairs of scutellar bristles might be considered to belong to a separate genus.

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(Received for publication, 21st November, 1941.)

ADDITION OF HORMONES TO MERCURIAL FUNGICIDAL DUSTS THAT REDUCE GERMINATION OF WHEAT.

Dusting of seed wheat with fungicides may at times cause a reduction of germination. It has been shown that a dust containing 1·5 per cent. of mercury as ethyl mercury phosphate, an effective fungicide, caused an appreciable lowering of germination of grain stored for periods of two to eight weeks before seeding (unpublished data).

As Grace (Can. Journ. of Res., Sec. C, Vol. 16, pp. 313-329, 1938) had shown that reduction in germination of formalin-pickled grain could be overcome to some

extent by the addition of growth hormones to the pickling solution, a few tests were made to determine whether these substances would reduce the loss of germination that follows storage with dusts containing ethyl mercury phosphate.

In a preliminary trial α naphthyl acetic acid and β indolyl acetic acid were each carefully ground into samples of a dust containing 1·5 per cent. of mercury as ethyl mercury phosphate, giving a range of concentrations of from 2·5 to 40 parts per million of the dry weight of the seed when the dust was applied at the rate of two ounces per bushel. The variety Ranee was used throughout.

Germination tests were made on blotting paper in a laboratory germination incubator after storage periods of two weeks and eight weeks at room temperature, duplicate samples of 50 seeds being used. After storage for 13 weeks a field germination test was made, the unit plot being a 100-seed row, and the treatments being replicated five times. The percentages of germination recorded for the treatments are shown in Table I.

TABLE I.

Percentage germination of wheat treated with dust, containing ethyl mercury phosphate (1·5% Hg.), without and with the addition of hormone substances. Rate of dusting=2 oz. per bushel.

Treatment.	Laboratory Germination.			Field Germination.	
	Stored 2 weeks.	Stored 8 weeks.	Mean.	Stored 13 weeks.	Stored 6 months.
Undusted	99	97	98	77·3	71·7
Dust, containing 1·5% E.M.P.	85	80	82·5	47·0	57·5
Dust+α naph., 2·5 p.p.m. ..	89	85	87	56·3	
Dust+α naph., 5 p.p.m. ..	87	85	86	51·3	
Dust+α naph., 10 p.p.m. ..	92	89	90·5	57·8	
Dust+α naph., 10 p.p.m. ..	90	80	85	58·3	
Dust+α naph., 40 p.p.m. ..	89	84	86·5	59·3	
Dust+β ind., 2·5 p.p.m. ..	91	88	89·5	64·8	61·7
Dust+β ind., 5 p.p.m. ..	89	86	87·5	59·3	
Dust+β ind., 10 p.p.m. ..	83	88	85·5	58·0	
Dust+β ind., 20 p.p.m. ..	85	88	86·5	55·8	
Dust+β ind., 40 p.p.m. ..	92	85	88·5	48·0	
Significant difference ..	6·1	6·1	4·5	14·2	

The hormone substances partly restored the loss of germinating power that was produced by the dust treatment. β indolyl acetic acid gave more consistent results under field conditions than α naphthyl acetic acid and was more effective at the lowest concentrations included.

In the laboratory germination studies it was observed that the mercurial dust reduced the average length of both the root system and the coleoptile, and that β indolyl acetic acid, except at the lowest concentrations, caused a still further reduction in the length of the root system and of the coleoptile, this reduction in length increasing with increasing concentrations.

As β indolyl acetic acid was more effective at the lower concentrations than α naphthyl acetic acid, a further trial was conducted. β indolyl acetic acid was used at concentrations ranging from 0·5 to 4 parts per million, with two mercurial dusts made by different processes, but each containing 1·5 per cent. of mercury as ethyl mercury phosphate applied at the rate of two ounces per bushel.

The dusted grain was stored six weeks in air-tight containers at room temperature before seeding. Six replications of twelve treatments were sown in a field germination trial, the unit plot being the 100-seed row. As the results for the two mercurial dusts were similar the mean figures only have been included in Table II.

TABLE II.

Percentage germination of dusts, containing ethyl mercury phosphate (1·5% Hg), with and without the addition of β indolyl acetic acid. Period of storage, 6 weeks at room temperature.

Treatment. (Mean of 2 dusts.)	Field Germination. (%)
Nil	75·2
Mercurial dust	59·1
Dust+ind., 0·5 p.p.m.	59·6
Dust+ind., 1 p.p.m.	59·5
Dust+ind., 2 p.p.m.	62·4
Dust+ind., 4 p.p.m.	65·1
Sig. diff. (S.E.×3)	5·9

Tables I and II show that β indolyl acetic acid, when incorporated in a dust containing ethyl mercury phosphate, slightly reduces the deleterious effect on germination.

It has been suggested that the observed effects may be due, either to the reaction between the mercurial dusts and the added substances reducing the amount of active material in the dust, or to the mechanical grinding of the dust causing a loss of volatile components. The lower germination where β indolyl acetic acid was included in concentrations greater than the optimum does not confirm this view.

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(Received for publication, 25th September, 1941.)

COMBINED SPRAYS FOR LATE TOMATOES.

In the near-coastal highland districts of Kulnura-Mangrove Mountain, tomatoes are planted out during December-January to supply the late tomato market between mid-March and late June. Unless these crops receive regular routine sprayings, considerable loss from pests and diseases is likely to occur. The more important of these are the fruit caterpillar, *Heliothis armigera*, the aphid, *Macrosiphum solanifolii*, and the tomato mite, *Phyllocoptes lycopersici*, together with early blight, caused by the fungus *Alternaria solani*, and late blight, caused by *Phytophthora infestans*.

Standard control measures for this pest and disease complex have generally consisted in the application, at regular weekly or fortnightly intervals, of combined sprays of lead arsenate and strong Bordeaux mixture, with the addition of nitocine sulphate for aphid control, or wettable or colloidal sulphur for mite control, as required.

The experiment reported below was conducted during the autumn of 1941, at Mangrove Mountain, to obtain data on the following points:

1. The relative value of copper oxychloride and of different concentrations of Bordeaux mixture for disease control.

2. The effectiveness of nicotine sulphate for aphid control, when added to the fungicides mentioned.

3. The effect of these sprays on yield.

Strong Bordeaux mixtures were known* to cause visible spray injury and were considered to have an adverse effect upon yield. Weaker Bordeaux mixtures

* Morgan, W. L., and Hely, P. C.: Agric. Gaz. N.S.W., 47: 691–693, 1936.

(1 : 1 : 40) used extensively by one of the writers (W. L. Morgan) had been shown to produce no visible injury and had apparently given good control of disease. In addition, the inclusion of nicotine sulphate with such weak Bordeaux mixture had resulted in excellent control of aphids, due partly to the fact that a very thorough spraying, which is essential at least for pest control, could be given without the risk of injuring the plant, whilst the alkaline reaction of the spray ensured efficient activation of the nicotine sulphate. Combined sprays of the necessary insecticides in Bordeaux, 1 : 1 : 40, appeared, therefore, to offer a satisfactory spray for routine weekly application.

Copper oxychloride suggested itself as a suitable alternative fungicide for such combined sprays, though there were indications from previous experiments (W. L. Morgan) that this material might prove less effective against early blight. In these experiments it was also found that the addition of nicotine sulphate to copper oxychloride sprays had not resulted in satisfactory control of aphids, even though several common wetting agents had been used. The addition of hydrated lime, however, appeared to improve aphid control.

Treatments.—The following treatments were tested on a crop of staked and pruned tomatoes of the Pritchard variety. The design of the experiment was a 6×6 Latin square, using single row plots each 32 feet long and containing approximately 30 plants, the rows being spaced 8 feet apart. The treatments were as follow :

A. Bordeaux, 1 : 1 : 20, plus nicotine sulphate.
B. Bordeaux, 1 : 1 : 20.
C. Copper oxychloride, 1 lb. : 40 gals., plus nicotine sulphate.
D. Copper oxychloride, 1 lb. : 40 gals., plus nicotine sulphate, and hydrated lime, 1 lb. : 40 gals.
E. Bordeaux, 1 : 1 : 40, plus nicotine sulphate.
F. Bordeaux, 1 : 1 : 10, plus nicotine sulphate.

The dilution of the nicotine sulphate was 1 : 400. Aphid infestation was not severe at any time in the crop and nicotine sulphate was added to the appropriate treatments only on 25th February and 4th March. To treatment D, hydrated lime was added only on these dates.

Lead arsenate for control of tomato caterpillar, at the rate of 3 lbs. to 40 gals., was included in all sprays with the exception of the last two applications, when it was reduced to 2 lbs. to 40 gals. Mite infestation did not develop sufficiently in the crop to necessitate treatment for its control.

Nine applications of spray were made from 18th February, when the lowest clusters of blossoms were setting, to 24th April, treatment being at weekly intervals, except between 25th March and 8th April.

Plot Records.—The fruit was harvested as it became fit to pick (though still green), and plot records were kept in the different treatments of the total number of fruits harvested, number and weight of marketable fruits, together with the number of fruits damaged by fruit caterpillar, early blight, or potato moth. The numbers of fruits exhibiting a scarred condition commonly known as " Cat face " or affected by blossom-end rot were also recorded.

Discussion.

Yield.—Plants sprayed with Bordeaux mixture, 1 : 1 : 40, out-yielded those in the other treatments, both in total weight of marketable fruit and also in total numbers of fruit harvested. The yield of marketable fruit in pounds was significantly greater in this treatment than in the treatments involving the use of Bordeaux, 1 : 1 : 10, or Bordeaux, 1 : 1 : 20, without nicotine sulphate. The difference between Bordeaux, 1 : 1 : 40, and Bordeaux, 1 : 1 : 20, plus nicotine sulphate, though not actually significant, was substantial (11 per cent.) Significantly smaller numbers of fruits were harvested from both the treatments involving the use of Bordeaux, 1 : 1 : 20, than from the 1 : 1 : 40 Bordeaux plots. There was no significant difference

TABLE 1.

Yields and Percentages of Damaged Fruits.

Treatment.	Marketable fruit. Yield in lbs. from six plots.	Total number of fruit harvested. Mean per plot.	Marketable fruits as per cent. total number of fruits.	Fruit Caterpillar.	Early Blight.	"Cat face" Scarred.	Potato Moth.	Blossom End Rot.
A	732	489	94·0	3·02	2·18	6·71	0·08	0·53
B	708	473	93·8	2·55	1·72	6·27	0·12	0·98
C	797	531	91·4	2·28	4·65	5·85	0·16	1·03
D	772	520	91·8	1·70	4·92	6·24	0·18	1·04
E	825	553	93·8	2·18	3·18	5·90	0·14	1·03
F	597	386	94·8	2·95	1·00	6·50	0·18	0·59
Differences for significance ..	114	60	—	—	—	—	—	—

between the copper oxychloride plots and the 1 : 1 : 40 Bordeaux in respect of either yield of marketable fruit or total number of fruits harvested. The lowest yield of marketable fruit and also the smallest total number of fruits harvested, occurred in the plots treated with Bordeaux, 1 : 1 : 10. The figures for this treatment were significantly below those of other treatments, with the exception of the plots sprayed with Bordeaux, 1 : 1 : 20, without nicotine sulphate.

It is considered that the small number of fruits and the low yield from the strong Bordeaux plots were due almost entirely to the destruction of blossom buds, flowers and young fruits. Even with a normal setting of fruits, injury to the foliage by this spray may be expected to affect the yield.

Percentage of Marketable Fruits.—The percentage of marketable fruits was significantly less in the copper oxychloride treatment plots than in any of the Bordeaux treatments. This was due largely to the heavier early blight infection on the fruits sprayed with the copper oxychloride. There was no significant difference in the percentage marketable fruit between the weak and strong Bordeaux mixtures.

Early Blight Infection.—At harvesting, the amount of early blight infection on the fruit was significantly least in those plots treated with 1 : 1 : 10 Bordeaux. It was significantly lower where Bordeaux, 1 : 1 : 20, was used without nicotine sulphate, than where Bordeaux, 1 : 1 : 40, or the copper oxychlorides had been used. However, the 1 : 1 : 40 Bordeaux sprayed plants did not show significantly more early blight infection on the fruits than those sprayed with 1 : 1 : 20 Bordeaux plus nicotine sulphate. All the Bordeaux sprayed plots were significantly freer of early blight than the two copper oxychloride treatments.

Estimations of the amount of foliage infection by early blight were made by Mr. R. D. Wilson, Plant Pathologist of the Department of Agriculture, on 24th April, by whose courtesy the following notes are included :

"The various strengths of Bordeaux and copper oxychloride were of some value in controlling early blight foliage infection, though, in no case, was absolute control secured. In this respect, copper oxychloride was definitely the least effective of the sprays used. Copper oxychloride and 1 : 1 : 40 Bordeaux caused no appreciable spray injury, whilst 1 : 1 : 20 and 1 : 1 : 10 Bordeaux, particularly the latter, injured the plants when applied at intervals of a week. Taking into account both spray injury and early blight control, the best spray appeared to be Bordeaux, 1 : 1 : 40. No definite correlation was found between the numbers of plants dying from Fusarium wilt and any spray treatment."

Tomato Aphid.—Aphid infestation was very light and the difference in yield shown by the two treatments (sprayed with Bordeaux, 1 : 1 : 20, with and without nicotine sulphate) is non-significant.

Fruit Caterpillar.—The first seven spray applications included lead arsenate at the rate of 3 lbs. : 40 gals. ; this was reduced to 2 lbs. : 40 gals. in the last two sprays.

From about mid-April onwards, very few eggs or young larvæ were present. In addition to the sprays used, the whole crop was dusted twice with lead arsenate between sprayings in late February and early March.

The percentage of fruit infested with fruit caterpillar was small and the differences between treatments are non-significant. The control value of the treatments, however, was very satisfactory, as in adjacent unsprayed plots a loss through fruit caterpillar of almost 30 per cent. occurred, as compared with less than 3 per cent. in any of the treated plots.

It is of interest to note that the addition of nicotine sulphate to the 1 : 1 : 20 Bordeaux-lead arsenate mixture gave no better control of fruit caterpillar than the 1 : 1 : 20 Bordeaux-lead arsenate mixture. This confirms the experience in other previous experiments, viz., that no improvement in tomato caterpillar control results from the addition of nicotine sulphate to lead arsenate-Bordeaux sprays.

The difference in potato moth damage, blossom-end rot infection and " cat face " were all non-significant.

Late Blight.—No late blight infection showed up in any of the treated or untreated plots ; consequently the experiment yielded no information in respect of control of this disease.

Conclusions and Acknowledgments.

For the regular weekly spraying of late tomatoes in the Mangrove Mountain-Kulnura area, a satisfactory fungicide for combined sprays is weak Bordeaux (1 : 1 : 40). Strong Bordeaux reduced yield through spray injury, whilst copper oxychloride, which did not cause injury, was less effective against early blight than the different concentrations of Bordeaux used. Bordeaux, 1 : 1 : 40, with lead arsenate (3 lbs. to 40 gals.) added for caterpillar control, and nicotine sulphate (1 in 400) as required for aphids, gave the highest yield of marketable fruit.

The writers desire to acknowledge the assistance of Mr. F. C. McCleery, Biometrician, in analysing the data ; also the help of Mr. R. D. Wilson, Plant Pathologist, in reporting on the incidence of disease.

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P. C. Hely.

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(Received for publication, 25th November, 1941.)

MANGANESE DEFICIENCY AND ACCUMULATION OF NITRATES IN PLANTS.

One of the essential functions of manganese in the plant is to catalyse the reduction of nitrates to amino-compounds, as was shown by Burström.[1] This suggests that plants suffering from manganese deficiency should contain abnormally high concentrations of nitrate. The following observations may be of interest in this connection.

Oats were grown on two soils on which the plant develops the typical symptoms of manganese deficiency, known as " grey speck ". One of these soils is a gravelly sand from the wheat belt of Western Australia ; this is being tested in pots. The other is a grey sandy loam, overlying yellow clay at about 18 inches. This covers a small experimental area in the grounds of the School of Agriculture of Melbourne

University, on which about sixty varieties of cereals are grown in single rows. It was heavily limed twenty years ago, and cereals thereafter suffered from "grey speck". The seeds are now regularly sown with a mixture equivalent to 300 lb. per acre of superphosphate and 20 lb. of manganese sulphate. With this treatment, oats still suffer from manganese deficiency, but barley and wheat do not.

Plants which had been sown in June were tested for nitrate in the stalk using 1 per cent. diphenylamine in sulphuric acid as described by Thornton *et al.*[3] and recommended by Wark.[4a, 4b] The tests were repeated on several sunny days in the second half of October, before panicles had emerged. Every oat plant that showed marked symptoms of manganese deficiency gave an intense reaction for nitrate. At the same time, "Dawn" oats, growing in two pots of the Western Australian gravelly soil which had been successfully treated to overcome "grey speck", did not show a trace of nitrate. Further, "Black Mesdag" oats growing on the University soil gave only a slight reaction for nitrate. This strain is relatively insensitive to manganese deficiency disease[2]; the yield of grain may be good, in marked contrast to most strains of *Avena sativa*.

Further tests were made with Canary grass (*Phalaris minor*). This is a common weed on this soil, and shows the same leaf-marking as oats when affected by manganese deficiency, though it is less sensitive than oats. Healthy plants again showed no trace of nitrate, while deficient plants gave an intense reaction. Wimmera rye-grass, growing vigorously in the same soil, showed no trace of nitrate in the stalk.

The nitrate in the soil at the time was less than one part per million of nitrogen.

School of Agriculture, G. W. Leeper.
Melbourne University.

[1] Burström, H.: Planta, 29: 292-305, 1939.
[2] Rademacher, B.: Abstracted in Rev. Applied Mycology, 15: 355, 1936.
[3] Thornton, S. F., Conner, S. D., and Fraser, R. R.: Purdue University Agricultural Experiment Station Circular 204 (revised), 1936.
[4] Wark, D. C.: (*a*) Journ. Aust. Inst. Agric. Sci., 4: 208-210, 1938; (*b*) *Ibid.*, 5: 224-227, 1939.

(Received for publication, 11th November, 1941.)

The Australian Institute of Agricultural Science

REPORT OF COUNCIL TO 4th GENERAL MEETING

Held at the School of Agriculture, University of Melbourne, on 11th November, 1941.

Gentlemen,

While, officially, this report covers the period to 31st December, 1940, the date of this general meeting requires that comment be made also on Institute activities during the months of 1941 which have already passed. In the last report mention was made of the anxiety of members of the Institute to contribute as directly as possible to the war effort. Since that was written we have come to realise some of the implications of total war, and although most members still perforce continue in their peace-time occupations, the significance of the contribution to be made in this way has become clearer. Australian products are being required in considerable volume and for many purposes, and in the organisation for the production of former staple commodities and also of new ones many Institute members have been very active. The possibilities of an even greater individual contribution will increase as the organisation of the nation as a whole becomes more efficient.

Membership.—At 31st December, 1940, the membership of the Institute was 458 corporate members and 21 student members, the respective Branch totals being as follow:

	N.S.W.	Vic.	S.A.	Q'land.	W.A.	A.C.T.	Tas.	Totals.
Corporate ..	125	112	59	58	54	33	17	458
Student ..	7	2	9	—	2	—	1	21

After allowing for resignations and cancellations of membership, the net increase in the number of corporate members for 1940 was 27. During 1941, 22 corporate members and 10 student members have been admitted to date. According to present information 29 members of the Institute have enlisted for service abroad or are on full-time defence duty in Australia.

Your Council regrets to record the death during recent months of Mr. C. E. Ahrens, Superintendent, Lord Howe Island ; Mr. R. T. Baker, formerly Lecturer in Forestry, Sydney University and Curator of the Technological Museum ; Mr. F. J. Rae, Director, Botanic Gardens, Melbourne ; and Mr. H. J. Hughes, formerly Principal of the Agricultural College at Muresk, W.A.

Branch activities have continued on a very satisfactory scale. Attendances and discussions at meetings have been encouraging.

Journal.—Despite paper restrictions and increased costs, your Council considers that this is still a very satisfactory publication. It acknowledges the Institute's debt for this result to the Editor, Dr. H. J. Hynes, and the Business Manager, Dr. N. S. Noble. Dr. Hynes has submitted his resignation as Editor as from 31st December next. This has been accepted with regret. Suitable action will be taken to recognise Dr. Hynes' devoted service as Editor of the Journal for a period of seven years. The New South Wales Branch has nominated as his successor Dr. F. T. Bowman, who is to be assisted in the editorial work by Dr. E. T. Edwards, Dr. I. A. Watson and Mr. F. C. McCleery. These gentlemen, together with Dr. N. S. Noble, Business Manager, and Dr. H. J. Hynes, will form the new Publications Committee. These recommendations have been approved by your Council.

Population and Potentialities Survey.—Most branches have encountered considerable difficulty in proceeding with this project, as it requires the assistance of so many people who are busily engaged with official duties. In New South Wales such a survey has been adopted as one of the official projects of the newly formed Division of Agricultural Economics of the Department of Agriculture, and it is to be hoped that similar developments may take place in other States.

Plant Quarantine.—It will be recalled that the third general meeting directed that the comments of the Branch Committees should be obtained on the report prepared by the Central Committee on Overseas Plant Quarantine, and that in the light of these a final report should be prepared and forwarded to the Standing Committee on Agriculture for submission to the Agricultural Council. Before this report was completed there was held in Canberra a Commonwealth conference on this subject and among the delegates were members of the Institute who had been active in our own enquiry. At their instigation, the Institute report was tabled at the conference and formed the basis of many of the recommendations made by the conference in a report which was later submitted to the Agricultural Council. In view of this development your Council decided that no good purpose would be served by forwarding the Institute report independently to the same body, so arrangements are being made for its publication in the next issue of the Journal with an explanation as to how it has been used. In reply to the request of the last general meeting that it should now examine the question of inter- and intra-State plant quarantine the Central Committee has reported that it considered these subjects unsuitable for examination and report by a Central Institute Committee and would recommend that they be considered by the Branch Committees in the States concerned.

Status and Salary Survey.—Copies of this report have been prepared and circulated to Institute members. Attempts to obtain comparable information for other professions were relatively unsuccessful. Members have, however, been referred to a survey conducted by the Australian Chemical Institute, the report of which was published in the proceedings of that Institute for March, 1940.

Agricultural Economics.—In the last report it was suggested that this subject, in its widest sense, was worthy of the attention of Institute members. During this year it has been seriously discussed by several Branches. A recommendation that the Institute should urge the formation of an independent body for agricultural economic research led to an expression of the opinion in many quarters that the primary need was a suitable training for workers in this subject. The matter is still under discussion.

Qualifications Committee.—The appointment of this committee to examine all applications for admission to membership was a direction from the last general meeting. After considerable discussion as to ways and means, the offer of the South Australian Branch to provide this committee was accepted and a committee of three appointed in July of this year. The committee has examined and reported on all applications received since that date.

Conclusion.—In concluding this report, your Council desires to say that while the period under review has not been one of spectacular achievements, it has been one of useful service both to members of the Institute and to the Australian community.

For and on behalf of the Council.

J. A. Prescott,
President.

THE AUSTRALIAN INSTITUTE OF AGRICULTURAL SCIENCE.

Income and Expenditure Account for Year ended 31st December, 1940.

1939 £ s. d.	EXPENDITURE.	1940 £ s. d.	£ s. d.
152 17 8	To Cost of Journal		153 4 0
56 6 3	,, Printing and Stationery		32 14 1
29 18 3	,, Annual Meeting Expenses		43 8 8
8 8 0	,, Audit and Accountancy Fees		8 8 0
8 12 6	,, Petty Cash and Incidentals		10 12 11
4 7 0	,, Survey Maps		1 4 0
	,, Grants to Branches—		
28 12 0	New South Wales	29 8 6	
27 10 0	Victoria	29 8 6	
15 13 6	South Australia	16 4 6	
13 9 6	Queensland	11 5 6	
12 7 6	Western Australia	12 18 6	
7 19 6	Federal Capital Territory	8 5 0	
4 2 6	Tasmania	4 19 0	
			112 9 6
£370 4 2	,, Total Expenditure		362 1 2
63 19 10	,, Surplus for Year		78 2 10
£434 4 0			£440 4 0

1939 £ s. d.	INCOME.	1940 £ s. d.	£ s. d.
	By New South Wales Branch, Subscriptions—		
13 13 0	Arrears	11 11 0	
99 1 0	Current	102 11 0	
			114 2 0
	,, Victorian Branch, Subscriptions—		
4 4 0	Arrears	10 10 0	
101 11 0	Current	102 7 0	
			112 17 0
	,, South Australian Branch, Subscriptions—		
4 9 0	Arrears	4 4 0	
57 3 0	Current	60 0 0	
			64 4 0
	,, Queensland Branch, Subscriptions—		
5 10 0	Arrears	6 6 0	
46 14 0	Current	36 15 0	
			43 1 0
	,, Western Australian Branch, Subscriptions—		
4 14 0	Arrears	7 7 0	
45 1 0	Current	42 10 0	
			49 17 0
	,, Federal Capital Territory Branch, Subscriptions—		
1 1 0	Arrears	1 1 0	
29 8 0	Current	30 9 0	
			31 10 0
	,, Tasmanian Branch, Subscriptions—		
—	Arrears	1 1 0	
15 15 0	Current	18 2 0	
			19 3 0
6 0 0	,, Interest		5 10 0
£434 4 0			£440 4 0

Balance Sheet as at 31st December, 1940.

1939 £ s. d.	LIABILITIES.	1940 £ s. d.	£ s. d.
	Sundry Creditors—		
117 19 6	Branch Grants	125 13 6	
9 15 3	General	33 18 11	
			159 12 5
3 3 0	Subscriptions Paid in Advance		6 6 0
303 12 0	Accumulated Fund, Balance at 1/1/1940	367 11 10	
63 19 10	*Add* Surplus for Year to 31/12/1940	78 2 10	
			445 14 8
£498 9 7			£611 13 1

1939 £ s. d.	ASSETS.	1940 £ s. d.	£ s. d.
9 5 0	Office Furniture—Sydney		9 5 0
	Cash at Bank—		
194 8 5	Melbourne	278 12 0	
28 14 2	Sydney	8 8 1	
			287 0 1
200 0 0	Fixed Deposits	200 0 0	
8 5 0	Fixed Deposits Accrued Interest	1 15 0	
			201 15 0
—	Australian Consolidated Bonds 3¼% due 15/8/56		100 0 0
54 1 0	Subscriptions Outstanding (since collected)		13 13 0
3 16 0	Petty Cash on Hand		
£498 9 7			£611 13 1

These are the Statements referred to in our report dated 14th May, 1941.

R. L. TWENTYMAN, Hon. Gen. Treasurer.

CLEVELAND, SON & HISLOP,
Chartered Accountants (Aust.).

MEETINGS OF COUNCIL.

At the meeting of Council held on 8th September in the School of Agriculture, Melbourne University, it was stated that the President of the Institute, who was a delegate at the A.N.R.C. Conference on Agricultural Economics, had written summarising the decisions made. The need for a course of training in agricultural economics at an Australian university was recognised, and it was left to the Vice-Chancellors for further decision. The A.N.R.C.'s proposal concerned post-graduate work only. The following were admitted to corporate membership : C. V. Hisshion, J. Meade, C. C. Crane, Miss K. M. Sawkins, D. M. McAlpin, R. J. Moir, T. J. Robinson, A. J. Millington and Miss N. Barrie. The following were admitted to student membership : A. H. Friend, J. Shipton, K. I. Rae, K. D. Woodyer, W. J. Ward and T. Gould. The recommendation of the Publications Committee that 2/– be added to each figure in the table of charges for reprints was approved. The intimation of the Editor (Dr. H. J. Hynes) that he wished to be relieved of the Editorship of the Journal at the end of 1941 was noted with regret. Financial statement showed a balance at bank of £219 5s. 6d. as at 8th September, 1941.

At the meeting of Council held on 10th November, it was pointed out that delegates were of the opinion that the present was an inopportune time for the Institute to take any official action on behalf of members as a whole, on the basis of the information summarised in the Status and Salary Survey Report. Acting on a report from the Publications Committee and a recommendation from the Committee of the N.S.W. Branch, Council recommended to principal delegates that " as from 1st January, 1942, the following be appointed members of the Publications Committee : Dr. F. T. Bowman (Editor), Dr. N. S. Noble (Business Manager), Dr. E. T. Edwards, Mr. F. C. McCleery, Dr. I. A. Watson, and Dr. H. J. Hynes. Recommended also that Dr. Hynes be appointed Chairman of the Publications Committee." Dr. R. J. Noble had intimated his wish to retire from this Committee at the end of the year and Council decided to convey to him its appreciation of services rendered in the past as Chairman. The following were admitted to corporate membership of the Institute : H. B. Parry and F. O. Grogan ; to student membership : J. R. Sutherland. The balance at bank as at 10th November, 1941, was recorded as £196 3s. 1d.

MEETINGS OF BRANCHES.

Australian Capital Territory Branch.

A meeting held on 28th August was addressed by Mr. C. M. Donald on " The Western Range of the U.S.A." The main vegetation types were reviewed and illustrated, and the history of the grazing treatment outlined. Fierce competition in the early days led to severe over-grazing, and it is now estimated that the carrying capacity of the range has been reduced by about 52 per cent. as compared with its virgin state. The effects of one-crop farming in the " Dust Bowl " areas were described. Remedial measures included the institution of national forests, governmental repurchase of marginal land, subsidy of improved farming practices, loans for equipment, and the work of the Soil Conservation Service. The range research methods developed by the Forest Service were described.

New South Wales Branch.

Résumé of addresses given at the August meeting will appear in the next issue.

At the general meeting held on 14th November, Mr. J. G. Crawford, M.Ec., gave an address on some interesting trends in American agriculture. The general objective of agricultural policy in America is the promotion of stability and security. In the United States, as in Australia, agricultural stability has been disturbed by domestic problems such as soil erosion, loss of soil fertility, ploughing up " grasslands ", tenancy difficulties, capital indebtedness, and the like. On a broader front, too, large sections of her agriculture have suffered export market restrictions in Europe and Asia, are similarly threatened by the failure of populations to grow as rapidly in the 20th century as in the 19th, by the development of substitutes for staple products, and by the general failure appreciably to improve the food and clothing standards in Europe, Asia and America. As in Australia, again, the situation is rendered more acute by the increasing aggregate efficiency of agriculture—i.e., the production of more and more food and raw materials with fewer persons engaged. If the problem is similar in the two countries, the approach differs in marked respects. Today " a fundamental characteristic of American agricultural policy is that it is predominantly active rather than passive, and well-nigh comprehensive, concerned with doing something about almost everything, agriculturally speaking ". There is a " rationale " about American agricultural policy (e.g. " income parity concept ") which is not yet apparent in Australian policy in any comprehensive fashion. Even if this fact merely reflects the farmers' political power in the Federal Congress and the greater wealth available for research, technical and economic, and education, the American programme is no less interesting as a large-scale experiment in social science.

Some objectives and techniques were then discussed, which are summarised as follows :

Greater stability and efficiency of farm production : Such as the A.A.A. production control, ever normal granaries, marketing quotas.

Greater stability of natural resources : Conservation of soil and its fertility ; better control of floods ; and conservation of forests, water, forage and wild life.

Greater stability of farm prices and income : Under this heading come the A.A.A. production control payments, loan system, and other subsidies.

Greater security of tenure.

Increasing the demand for agricultural produce.

Victorian Branch.

On 25th August, members met and discussed generally " Government Planning of Agriculture in Australia ". The subject was introduced by the President, Mr. G. W. Leeper, who explained that planning, in some form or other, had been accepted gladly or reluctantly and that the form of a plan necessarily depended on one's outlook. Papers were contributed by Dr. H. C. Forster on " Methods of Control and Planning " ; Mr. W. B. Miller on " Factors in Planning the Wheat Industry " ; Mr. H. L. Hore on " The Stabilisation of the Wheat Industry in Australia " ; and Mr. F. M. Read on " The Control of the Dried Fruits Industry ". Professor Wadham spoke on the possible trend of events under planning as opposed to a system of *laissez-faire*. The papers were circulated to members before the meeting and were of considerable assistance in promoting and expediting discussion.

Institute members also attended the following meetings of the Melbourne University Agricultural Society :

On 19th September, Mr. R. E. Holttum, M.A., Director of the Botanical Gardens, Singapore, gave an interesting address on " Horticulture in Malaya ", drawing particular attention to the physiological behaviour of plants under tropical conditions.

Mr. F. R. Drake, Assistant Agrostologist of the Department of Agriculture, discussed " Lawns and Playing Greens " on 24th October. He described the high degree of proficiency of turf culture in Victoria and suggested that the successful upkeep of greens depended mainly on the control of insect pests and fungous diseases, the selection of suitable species and correct and adequate manurial treatment. Cockchafers were the most serious pest and could be controlled with lead arsenate. Mercurial compounds were effective against most fungous diseases but the question of economic application should be further investigated. New Zealand browntop and Chewing's fescue made an excellent mixture for fine lawns and sporting turf, while a dryland type of the former species, with strong rhizomes, was becoming known for its hardiness. Regular treatment with nitrogenous fertilisers and a small amount of super were essential to maintain a vigorous, weed-free turf, continued Mr. Drake. Sulphate of ammonia gave excellent weed control but excessive use may damage turf. On test plots good results had been obtained with a mixture of sulphate of ammonia and an organic fertiliser, such as blood and bone.

Queensland Branch.

A meeting held on 29th August was devoted to a symposium on Symbionts. Mr. H. E. Young opened the discussion with a talk on mycorhiza. He dealt with the development of ideas on mycorhiza, and then pictured the fungus as extensively increasing the root-hair system. The mycelia break down raw organic matter in the soil and also take up inorganic soil nutrients and pass these, together with amino-acids, carbohydrates, etc., to the plant roots. The fungus gains phosphatides from the higher plant. Mycelia are of two structural types, ectotrophic and endotrophic, and these were treated in turn. The mycorhizal habit, while possibly of critical importance to plants exposed to competition in the field, may play an insignificant part in the nutrition of the same species sheltered from competition. The speaker showed the correlation between incidence and character of infection and the nature of the rooting medium, and the relation to the vigour of the host. He illustrated his point in the case of citrus, and used fused-needle disease of *Pinus* to show the relationship of mycorhiza to plant health. Here the type of mycorhiza enables one to form an opinion on the state of the soil, and advise remedial measures.

Mr. T. McKnight dealt with root nodule bacteria. He discussed the mode of infection of the leguminous host and the specificity of rhizobial strains. Efficient strains produce larger and more persistent nodules. The quality of nitrogen fixed and the mechanism of fixation were dealt with. The furnishing of vitamins of the B complex has been established, while legumes themselves produce biotin. The speaker discussed the suggested methods of transmission of nitrogen from nodule to host, and the factors affecting the symbiosis, such as aeration, moisture, pH and mineral nutrition. Finally he mentioned the importance of bacteriophage and its connection with effective symbiosis.

At the meeting of the Branch held on 17th October, Mr. H. S. Hunter, State Director of Marketing, delivered an address on the Queensland plan for collective marketing of primary products, which has been adopted in nearly all the English-speaking countries of the world since its formulation in Queensland in 1920. The basic feature of the plan is what might be

described as compulsory cooperation. The several Australian governments gained valuable experience in controlled marketing during the first World War, but only in Queensland was an effort made to take advantage of this experience after the war. For any commodity a Pool Board is set up if desired by a majority of the producers of that commodity, and the Board is granted a monopoly of administration of the total output of that commodity. The first pool was the Queensland Wheat Pool, set up in 1920, and other pools now in operation control arrowroot, Atherton Tableland maize, barley, broom millet, butter, cheese, cotton, eggs, honey, North Queensland pigs, plywood and veneer (north and south), peanuts and fruit. The operations of the various Boards were outlined by the speaker, and the difficulties encountered with section 92 of the Constitution were explained.

Western Australian Branch.

A well attended meeting on 26th September was addressed by Mr. H. R. Alexander, a field officer of Commonwealth Fertilisers Ltd., on " Pastures in Victoria and the Riverina ". The talk was illustrated by numerous lantern slides, including some of pasture seed production in New Zealand. Mr. Alexander outlined the success which had followed pasture establishment investigations, and outlined the various conditions most suited to pasture species such as subterranean clover, Wimmera ryegrass, perennial ryegrass and *Phalaris tuberosa*. The need for sound fertiliser practice was also stressed.

On 30th October the Branch was the guest of the W.A. branch of the Australian Chemical Institute, when the evening was devoted to a discussion of malting and brewing. As a basis for the discussion, three short papers were presented, " The Cultivation of Malting Barley ", by Mr. R. P. Roberts, " Malting ", by Mr. L. Barrett, and " Brewing ", by Mr. I. G. McCall.

Tasmanian Branch.

The third open meeting of the Tasmanian Branch for 1941 was held at the Department of Agriculture, Launceston, on 11th August. A visiting Victorian Branch member, Mr. A. A. Lee, Chief Agricultural Officer of the Flax Production Committee, addressed the meeting on the " Flax Industry ". The speaker traced the history of the industry from early biblical days and showed that prior to the war Russia produced some 70-80 per cent. of the world's output of fibre. In regard to the flax industry in Australia, Mr. Lee said that the crop was first sown in Victoria in 1862, and that in 1939 there were 2,000 acres in that State. In 1940 some 20,000 acres were sown in the Commonwealth, and in 1941, 60,000 acres had been sown. The main botanical and physical features of the two main fibre producing varieties—Liral Crown and Concurrent—were outlined. The address was illustrated by slides depicting various phases of the industry in Australia. This was followed by a film of the industry in England, and shots were shown of a new machine of foreign origin, which pulled and spread the straw for dew retting in one operation. The lecture was enthusiastically received by a most appreciative audience.

Current Notes and News

Agricultural Economics Research.

The following statement is submitted by the A.C.T. Branch of the Institute:

At a meeting of the Council of the Australian Institute of Agricultural Science, held in Melbourne on the 14th July last, there was some discussion on a motion, submitted by this Branch, calling for the establishment of an organisation to undertake research in agricultural economics.

While there appeared to be fairly general agreement that work in agricultural economics is desirable, a number of objections were raised to the proposals put forward by this Branch. Since some of these objections appeared to us to be based on a misunderstanding of our proposals, the Council, at a subsequent meeting, agreed to defer taking a formal vote on the matter in order to give us an opportunity of restating our views and answering, as far as possible, the objections raised.

As far as can be gathered from the minutes of the Council meeting of the 14th July, the main objections put forward by other branch delegates to the A.C.T. Branch motion appear to be:

(1) The proposed organisation, to be effective, should be independent of the States and Commonwealth.
(2) There is a lack of adequately trained personnel to conduct research in this field.
(3) The Central Committee would find it impossible to obtain sufficient and reliable data.
(4) The proposals are too vague, and action based on them would be premature.
(5) The proposals do not take cognisance of existing work in this field.

Taking these objections in turn, it will be noted that, in the motion submitted by us, we refrained from specifying the precise form and status of the proposed organisation. It may be that the work could be most effectively performed by an organisation independent of governments

and of existing bodies, but against this view, we feel that such an organisation would probably be hampered by inadequate finance and by the lack of official standing in collecting data. We are in entire agreement with the view that framing and implementing policy is a function of the politician, and stressed the point that the proposed organisation should confine itself to collecting and collating facts on which a national policy may be based. The suggestion was made, though not as an integral part of our motion, that the formation of a Division of Agricultural Economics as a part of the C.S.I.R. would best combine relative freedom from political interference with an assurance of adequate finance and " status ". This, and possible alternative proposals, could be considered when the general principle of forming an organisation is accepted.

The lack of trained personnel was taken into consideration in formulating our proposals, and we were also aware at that time that the Australian universities were proposing to train students in agricultural economics. We feel that the objections under this head, while real, are by no means insuperable. It was specifically suggested that the organisation should be initially a small one, and we are convinced that there are in Australia enough men, trained in economics with an agricultural bias, to form the nucleus of such an organisation. Difficulty might be encountered in finding here a man with the knowledge and ability to direct the organisation, but there are in America, and to a lesser extent in Britain, many highly trained agricultural economists from among whom it should not be impossible to attract a suitable man. There are ample precedents for such a course in the existing divisions of the C.S.I.R. Furthermore, we can hardly expect that suitable people will be attracted to the study of agricultural economics in our universities if their only hope of employment is in a non-existent organisation.

The suggestion was made that, as State branches of the Institute have found great difficulty in collecting adequate data on agricultural potentialities, a Central Committee would encounter much greater difficulties. In fact, a " Central Committee " of any kind is the last thing which we wish to see. A major function of the proposed organisation would be, working from the farm up, to collect data, the lack of which has been felt by all sections of the community from individual research workers to Royal Commissions. Admittedly, it could deal with only a very limited field at first, but within that field it can hardly be doubted that an organisation, with an adequately trained full-time staff, could collect more useful and reliable data than could workers in other fields who are only able to devote their spare time to the study.

The " vagueness " of our proposals was deliberate—and for two main reasons. As mentioned in our previous memorandum, some of the objections raised to the proposals of the Australian National Research Council appear to have been based on the undue rigidity and detail of those proposals. This was a pitfall which we wished to avoid. More fundamentally, however, we felt that, as agricultural research workers in other branches, with no detailed knowledge of agricultural economics, we would not be competent to submit detailed proposals. We, in common apparently with most members of other branches of the Institute, have felt the urgent necessity for adequate data on agricultural economics, and our motion was advanced to call attention to the need for the establishment of an organisation to accumulate such data. The programme of work of such an organisation would have to be settled when agreement was reached on its establishment, and no doubt the contribution of the sub-committee of the South Australian branch would be most helpful at this stage.

We are quite aware that limited but valuable work on agricultural economics is already being conducted in Australia; indeed, one of the main functions of our proposed organisation was stated to be " the collation of information having a bearing on agricultural economics that is at present collected by various bodies, both State and Federal ". We feel strongly that the information at present being accumulated, often by isolated workers and under considerable difficulties, can have its full value only if collated and thrown into perspective by a central organisation.

Finally, we wish to stress the urgency of the matters at issue. Agricultural production and marketing in Australia today are regulated at every turn. This regulation, greatly emphasised by war-time necessities, was none the less developing strongly before the war, and there seems little reason to suppose that we shall return to unrestricted production and universal free trade in the post-war era. The controls governing Australian agriculture and affecting the life and income of every farmer have been established all too frequently under the stress of urgency and without adequate data to assess their economic effects on the agricultural population. There seems little hope that this position can be improved until an organisation is established whose function it is to accumulate—however slowly—data on the economic aspects of agriculture. The Commonwealth Government is paying particular attention to post-war reconstruction, as shown by its creation of a special department to deal with the questions involved, and an organisation for the study of agricultural economics would form a useful complement to that department. That the formation of such an organisation should be fostered by the Australian Institute of Agricultural Science is particularly appropriate. The individual research worker in any branch of agriculture must feel that the increase of production, so long regarded as his goal, can no longer be a satisfactory objective unless he can feel also that such increased production will lead to a better standard of living for the farmer. Such an assurance hardly exists today, and it is this need for the fundamental factual information on the economic problems of Australia's rural industries, felt so keenly today, which the proposed organisation would help to supply.

New Charges for Reprints

Reprints of articles published in this Journal are available at the new rates set out hereunder. The attention of authors is directed to the fact that no responsibility is taken for supply of reprints *unless* orders are forwarded with the manuscripts.

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5–6	29/6	32/6	37/6	42/6	47/6
7–8	37/–	39/6	44/6	49/6	54/6
9–10	44/–	46/6	52/6	57/–	64/6

Correspondence

INTERNATIONAL COMPARISONS OF AGRICULTURAL PRODUCTIVITY

Editor,
A.I.A.S. Journal.

Sir,

In a calculation recently published in the book, " The Conditions of Economic Progress ", I set out to compare the real productivity of agriculture in different countries by taking the physical volume of the principal agricultural and pastoral products and valuing them at uniform prices (those of U.S.A. during the period 1925 to 1934). These values were aggregated and divided by the number of male farmers and farm workers in each country in order to determine the real productivity per head.

Mr. J. A. Aird, in the September issue of this Journal, has contended that " the comparative efficiency of the rural workers in each country can be compared more closely if local prices are used ".

If I had wanted to compare productivity on the basis of local prices prevailing in each country, it would never have been necessary to go to the trouble of itemising each country's products and revaluing them at uniform prices. Most countries already prepare statistics showing the net money value of primary production. It is true that they differ slightly in definition. Net production in Australia is defined as that part of the product available to meet wages, interest, rents, taxes, depreciation and drawings by the farmer, together with certain minor expenses. In 1934–35, the year for which production was compared, this figure stood in Australia at £245 per male person engaged. The comparable figures, so far as they can be computed, were £309 for New Zealand and $694 or £A174 for the U.S.A.

But having got such a result, what use is that for our present purpose ? The object is, not to compare money productivities, but real productivities. The distinction between real and money income is fundamental in economics.

The definition of " real income " undoubtedly involves considerable difficulties, which the reader may study in recognised treatises such as Professor Pigou's " Economics of Welfare ". But to abandon the use of real income and to confine oneself to figures of money income is to abandon economics for accountancy.

Mr. Aird, therefore, in criticising my calculations has missed their essential object, namely to make the first approximate determination of the *produced real income** of agriculturists in different parts of the world. For my purpose I defined the unit of real income as the amount of goods or services exchangeable with such amount of goods or services as sold for $1 in the U.S.A. over the average of the period 1925–34. Because this was primarily intended for international comparisons, it was called an international unit. Mr. Aird contends that the units of my inter-

* Where the relative prices of agriculture and non-agricultural goods are subject to change, the amount of real consumption which the agriculturalist can enjoy per unit of real production will also change. " Produced real income " must, therefore, be distinguished from " consumed real income ".

national comparisons " are described as international units . . . but are actually United States dollars ". An international unit is no more the same thing as an American dollar than an apple is the same thing as a penny.

It may be added that nearly all the world's worst economic blunders spring from this same source, namely the failure to distinguish between real values and money values. At the moment, Australia is destroying real wealth in the form of apples in order to save a certain amount of unreal wealth in the form of money. People think that they are helping to win the war by putting money into war loan, whereas only by reducing their real consumption or increasing their real production can they make any real contribution. Britain has been selling Australia considerable quantities of unnecessary exports which increase British money income but deplete real British resources. And so on indefinitely. There is nothing more important than to distinguish between real values and money values.

I do not accuse Mr. Aird of failing to make this distinction. What he appears to be seeking is the *consumed real income* of agriculturists in each country, by determining their money incomes and then dividing by the price of secondary products. This is an important object, but it was not what I was looking for. It is clear that the consumed real income of the farm population will be affected by any intervention of the Government in the marketing of primary products. My object was to obtain a measure of the real productivity of different farm populations, independent of any such juggling of prices. It is clear that this can only be done if we use some international schedule of prices.

Now any such calculations of real income can generally be made in two or three different ways, giving slightly different results. After considerable reflection I took American prices for the international valuation. It is true that they have their defects, but these defects are less than those of any other single schedule which could have been taken. It is true that, as Mr. Aird points out, a much larger proportion of the milk production is sold whole in the U.S.A. than in Australia or New Zealand. This has the effect of making Australian real production look very high in comparison with money production, and that of New Zealand even more so. It must be remembered, however, that this table is required for making comparisons over a very wide range of countries, including some such as Great Britain where the proportion of milk sold whole is still higher than in the U.S.A. Australia and New Zealand are at the extreme end of the scale in this respect.

The other principal difference to which Mr. Aird draws attention is that I have treated " sheep and lambs " as a single commodity with a single price, whereas in America this aggregate includes a much higher proportion of lamb than in Australia. Consequently the uniform price is not comparing like with like.

For purposes of argument only, I will admit that milk sold whole is to be regarded as a different commodity, with a different international price, from milk sold as cream or butter ; lamb also from mutton. In the case of the other commodities there is no important difference between Australian and international prices.

Now the recognised procedure for comparing real productivities, when two countries produce goods at different prices, and if we have no grounds for preferring one price to the other for purposes of international comparison, is to construct an " ideal " index number. It has been shown mathematically by Professor Pigou that figures of real income computed in this manner will show the least possible discrepancy from their unknown true value. The method involves, in fact, pricing the Australian output at Australian, then at American prices and noting the ratio of the results, then pricing American output at both prices, and again noting the ratio of the results ; then taking the geometric mean of the two ratios. The calculation is as in the accompanying table,* using Mr. Aird's prices for butter fat, mutton and lamb.

Using American prices, therefore, the real volume of American production appears to be 9·2 times that of Australia. But using Australian prices, American production is only 7.63 times that of Australia. The geometric mean of these ratios is 8·4. By the previous method of calculation, using American prices only and treating milk as a single article, a ratio of 7·73 was obtained (American production 6,550 m. international units, Australian 847 m.). If we accept all of Mr. Aird's criticisms, therefore, the ultimate effect is to lower by 8 per cent. the measure of Australian real productivity as compared with American.

However, I do not think that milk sold whole should be regarded as an economically different commodity from milk sold separated. What the farmer produces in either case is milk. Whether or not it can be sold whole depends largely on questions of transport. Transport facilities so far have been rapidly improving everywhere. The distinction between the two markets has broken down in England, and distinct prices can only be maintained by the use of the elaborate machinery of the Milk Marketing Board. Whole milk is even becoming a subject of international trade. Hawaii and the Panama Canal zone import from U.S.A., the Dutch East Indies (in peace

* American statistics of sale values do not distinguish milk sold for cheese from other milk sold whole, and indeed they are interchangeable commodities. Strictly speaking, a small debit should also be made, as Mr. Aird suggests, for separated milk consumed on the farm by livestock, but this would have no appreciable effect on the calculations.

	Quantities 1934–35 m. Quintals.		Average Prices $ per Quintal 1925–34.		Products.			
	U.S.A.	Aust.	U.S.A.	Aust.	Aust. Goods at American Prices.	American Goods at Aust. Prices.	Aust. Goods at Aust. Prices.	American Goods at American Prices.
Milk sold whole or consumed by farm families	301	10	4·70	3·03	47	912	30	1,414
Milk sold as cream or butter	148	44	2·41	1·66	106	246	73	357
Lamb	3·4	1·1	32·8	23·1	36	79	25	112
Mutton	1·8	2·0	16·4	15·5	33	28	31	30
All other entries (net)	—	—	—	—	552	4,637	552	4,637
Net total ..	—	—	—	—	774	5,902	711	6,550

time) from Holland. Prophecy is not a venture to be frivolously embarked upon, but I think that there are good grounds for anticipating that within twenty years we shall see " milk tankers " plying between Australia and Asiatic ports.

I contend, therefore, that for the object in view, namely the measurement of produced real income, revaluation of each country's output at American prices gives a reasonable first approach to the result. It is true that the output needs considerable further subdivision (e.g., between fowl and turkey meat, as Mr. Aird has suggested). My results already need bringing up to date, and there is plenty of other scope for improvement. But we shall get nowhere by going back to local prices in each country.

I have left entirely unexplored the question of *consumed real income* of farmers in different countries ; except of course that consumed real income must be determined by four factors :

(*a*) Produced real income.
(*b*) The transportability and transport costs of the product.
(*c*) The world terms of exchange between primary and other products.
(*d*) Any local variations of these terms of exchange.

Mr. Aird remarks that from meeting New Zealand agriculturists, he certainly did not get the impression that they had the highest real income per head of any agriculturists in the world, whether produced or consumed. I venture to suggest that from conversation with New Zealanders he did not obtain any impression of the number of motor cars per thousand of population in Australia and New Zealand, which numbers are, in fact, as follows :

Australia	80
New Zealand	140

New Zealanders have a remarkable capacity for grumbling and minimising the extent of their prosperity. Being direct descendants of Adam, they would undoubtedly grumble at Paradise.

Mr. Aird questions a table extracted from the Report of the New Zealand Dairy Farm Inquiry (original data in New Zealand Year Book, 1938). This table showed that butter-fat produced per man-year of labour increased with increasing size of herd. There was also a figure of acreage, which rose on a maximum of about 50. I regret that there was a copying error in the head of this table. The last column should have been headed " Acreage used for dairying *per man-year* ".

Mr. Aird apparently thought that his article would not be sufficiently interesting unless he enlivened it with a little personal abuse of economists for supposed lack of knowledge of agriculture. This is a sore point with me. Just before the depression I bought a small farm and operated it for six years. I often wish that I did know less about agriculture.

COLIN CLARK,
Bureau of Industry,
Brisbane, Q'ld.

19.11.41.

Editor,
A.I.A.S. Journal.
Sir,

The September number (1941) of this Journal gives pride of place to an article by Mr. J. A. Aird criticising a chapter out of Mr. Colin Clark's book, " The Conditions of Economic Progress ". Mr. Aird raises in an acute form the problem, " What (if anything) do we mean by productivity ? " Since our Institute has for some years been trying to estimate the agricultural productivity and potentialities of Australia, I should like to comment on this article.

The chapter in question is an attempt to estimate the production of wealth per rural worker in each of several countries. Mr. Clark concludes that in the two-year period, 1934–35, British and American agriculture were respectively one-third and one-half as productive as Australian; while New Zealand agriculture was over 50 per cent. more productive. Mr. Aird finds these ratios incredible, and makes two main criticisms—that Mr. Clark has used the wrong figures, and that what he has tried to do is impossible, anyway.

The only way of comparing the productivity of an Australian dairyman, an American wheat-grower, and an English potato-grower is to say, one sack of potatoes equals x gallons of milk, one bushel of wheat equals y gallons. Eventually we get all the rural production in terms of gallons of milk, and so find production per worker. This is what Mr. Clark has in effect done. Mr. Aird evidently disagrees with his values for x and y, but he does not propose an alternative set of values. Even if we agree that all the prices for animal products quoted on p. 92 of this Journal for September are too high, that cannot destroy Mr. Clark's main conclusion. Since Great Britain is normally a producer of livestock and importer of wheat, the use of Mr. Aird's lower figures instead of Mr. Clark's would actually increase the very ratio of 3 to 1 in favour of Australia which he finds so incredible. The only criticism which seems to me serious is that Mr. Clark has failed to separate wool into high and low grade. But if we insert the appropriate low-grade figure for New Zealand wool, New Zealand still remains 50 per cent. above Australia.

However, Mr. Aird's criticism goes much further than this. He will not allow that a gallon of milk in Australia equals a gallon of milk in America (where more of the milk is drunk and less turned into butter than here) or in Norway (where, as Mr. Clark points out, productivity is very low). Here I think he misses the whole point of the book which he is criticising. Thus, after calling attention to the low productivity in Norway (p. 93, last paragraph), he asks : " Is it sound economics to compare the productivity of the Norwegian dairyman with that of the Australian on the same price basis ? " Of course it is. That is what the book is about—namely the amounts of commodities produced in a year of work. If we agree with Mr. Aird's implication that the answer to his question is " No ", then as Mr. Clark points out on p. 27 of his book, the whole subject of economics collapses.

Personally, I find no difficulty in accepting Mr. Clark's ratios for Britain, America, and Australia. A lot of American agriculture is highly productive, but the average is weighted by vast areas of rural slums. The British farmer may get three times as much wheat per acre as the Australian, but what an array of rural workers in Britain and the two Americas have played their part in producing it !

As Mr. Aird points out, the table quoted on p. 95 in the Journal is obviously wrong. If, however, " acreage used for dairying " is changed to " acreage used for dairying per worker ", it makes sense. The author was evidently careless in dealing with this table ; however, this does not touch the main topic now under discussion.

G. W. Leeper,
The University,
Melbourne, Vic.

11th November, 1941.

Obituary

FREDERICK JAMES RAE

It is with regret that we record the death, on 18th September, 1941, of Mr. F. J. Rae, Director of the Melbourne Botanic Gardens and Government Botanist for Victoria. Past President of the Melbourne University Agricultural Society and foundation member of the Victorian Branch, A.I.A.S., the late Mr. Rae was a well-known and highly esteemed personality.

Born at Blackwood (Vic.) in 1883, he was a school teacher for some years and graduated at the University of Melbourne in Arts and Science, and in 1915 in Agricultural Science. He served in the Great War with the Field Artillery and Australian Flying Corps and on his return in 1918 was appointed to the School of Primary Agriculture and Horticulture at Burnley, first as Science Master and in 1921 as Principal. He went to the Botanic Gardens as Director in 1926 and during his fifteen years in that position was responsible for many improvements. With his wide knowledge of plants and their habits, Mr. Rae took a keen interest in the development of gardens, both private and public. As Government Botanist he reorganised and extended the useful work of

the National Herbarium. In addition to his horticultural interests, Mr. Rae was an active executive member of the Royal Society and the Honorary Justices' Association. He was also a member of the University Standing Committee of Convocation, as a representative of Agricultural and Veterinary Science, and was an ardent worker on behalf of the Returned Soldiers' League.

Deepest sympathy is extended to his widow, also his son who is in the R.A.A.F.

HUGH JASON HUGHES

The death occurred on 27th September, 1941, of Mr. H. J. Hughes, B.A., formerly Principal of the Muresk Agricultural College. The late Mr. Hughes, who was aged 67 years, came from New South Wales as a young man to join the Education Department in Western Australia. He taught at the Perth Boys' School and became headmaster of the Claremont Central School and, subsequently, inspector of schools in the Northam district. When Muresk Agricultural College was founded in 1925 he became the first principal and occupied that position till his retirement in 1938. At Muresk he applied the results of experiences of older agricultural colleges, gained while travelling in Australia and England, and set the young college on a sound footing. Since his retirement, Mr. Hughes had interested himself in A.R.P. matters and was a member of the A.R.P. Report Centre.

He is survived by a widow and three daughters, to whom we extend our sincere sympathy.

Personal Notes

At the General Meeting of the Institute in Melbourne on 11th November, Professor J. A. Prescott was unanimously re-elected President for the ensuing period.

Lieutenant-Colonel J. K. Murray, Commander of Training Depots, Northern Command, A.M.F., has been promoted to Colonel. Colonel Murray is Professor of Agriculture at the University of Queensland and Principal of the State Agricultural College.

Mr. J. L. Schofield, Director of the Bureau of Tropical Agriculture, now has his headquarters in Brisbane.

The following members of the South Australian Branch have enlisted in the fighting services : A.I.F. : J. G. Baldwin, J. R. Goode, R. M. Baker (Student), P. F. Butler (Student), C. M. E. Mayo (Student), P. J. Young (Student) ; R.A.A.F. : S. M. Close, H. K. Kemp, T. H. Strong, J. A. Beare (Reserve).

Mr. A. W. Jessep has been appointed Government Botanist and Director of the Botanic Gardens, Melbourne, in place of the late Mr. F. J. Rae. Since 1926, Mr. Jessep had been Principal of the School of Primary Agriculture and Horticulture, Burnley, Victoria.

Mr. H. A. Mullett, Director of Agriculture, has been elected a member of the Standing Committee of Convocation at the University of Melbourne, as a representative of Agriculture and Veterinary Science.

Major J. Brake, who is on extended leave from the Department of Agriculture, has been appointed O.C., Melbourne University Rifles.

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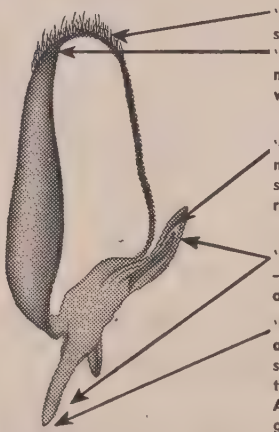

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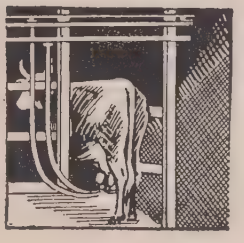

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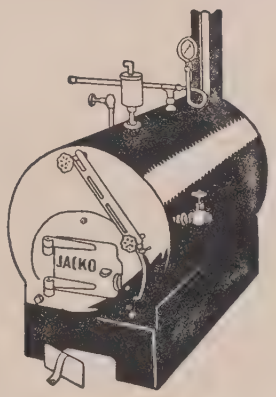

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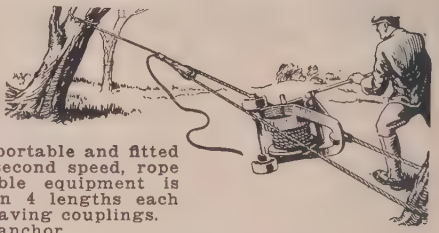

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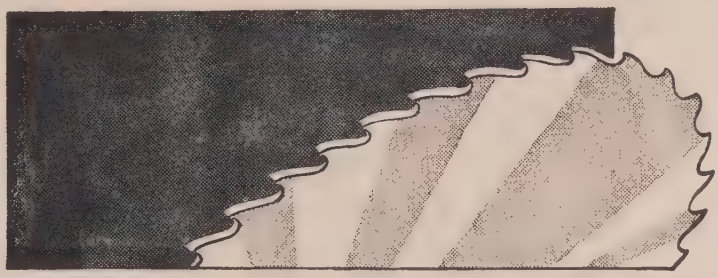

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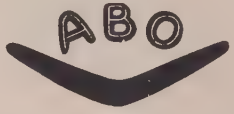

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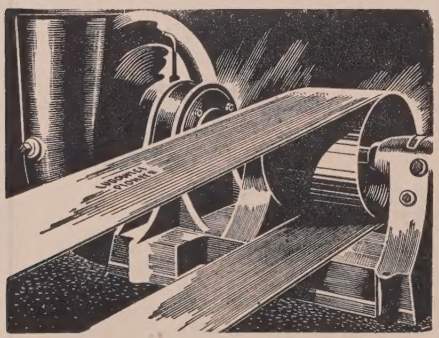

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